



**DEPARTMENT OF HOMELAND SECURITY  
CUSTOMS AND BORDER PROTECTION  
FACILITIES MANAGEMENT & ENGINEERING  
BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE  
TACTICAL INFRASTRUCTURE DESIGN STANDARDS**

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# **Chapter 1 – Road, Bridge & Signage Design Standards**

## SECTION 1. ROAD TYPES

Four types of roads have been identified by Customs and Border Protection (CBP) as part of a system in which roads are maintained to meet specific standards according to their functional classification (FC). These Four types are as follows:

- *FC-1 Paved Road* – All-weather road constructed using flexible or rigid pavement (e.g., asphalt, concrete). The road has two lanes with a total road width of (b) (7)(E).



Figure 1 – FC-1 Paved Road

- *FC-2 All-Weather Road* – All-weather road consisting of a surface of imported aggregate material, such as milled bituminous material or processed aggregate gravel mixture. The road has two lanes with a total road width of (b) (7)(E).



Figure 2 – FC-2 All-Weather Road

- *FC-3 Graded Earth Road* – An unpaved road constructed of graded, native material. The road has two lanes with a total road width of (b) (7)(E).



Figure 3 – FC-3 Graded Earth Road

- *FC-5 Sand Road* – Sand dunes road that follows the natural contours with improvements to road sub-base, by means of cellular confinement or mechanical concrete, and road pavement section only. The road has two lanes with an overall road width (b) (7)(E) l.

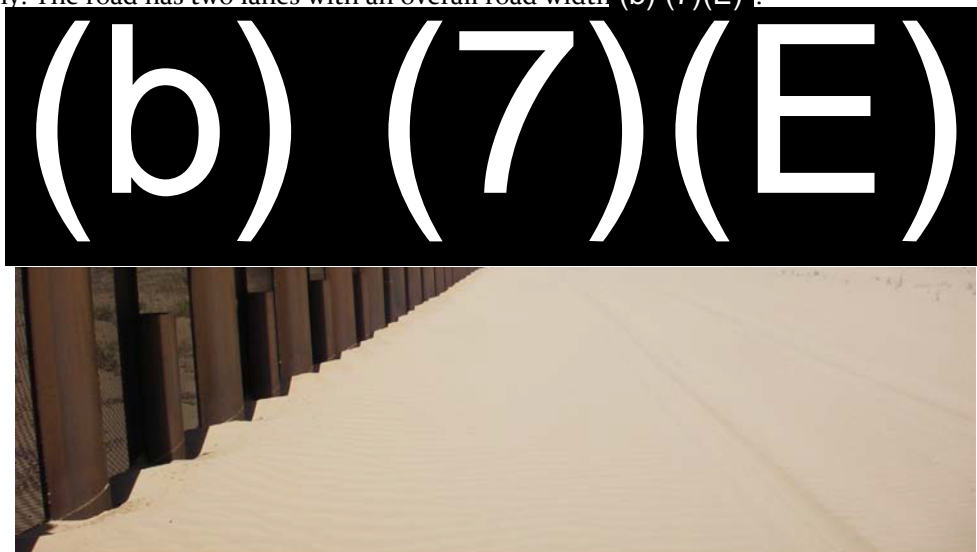


Figure 4 – FC-5 Sand Road

## 1.1 PURPOSES OF ROADS

There are four purposes for the four FC road types identified in the CBP program, border road, access road, temporary construction road and operations road. For the purposes of these design standards, the four FC road types are the baseline for all border and access road improvements or new construction, in addition to maintenance and repair activities. The two other road types commonly used by CBP, temporary construction roads and operations roads, are not covered under these Tactical Infrastructure (TI) Design Standards. While temporary construction and operations roads each serve a function

within CBP operational requirements, as described under **Section 1.1.3, Temporary Construction Road** and **Section 1.1.4, Operations Road**, they are not required to meet standard design criteria. See **Section 3, Cross Section Design Standards**, for additional cross section features.

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#### **1.1.1 BORDER ROAD**

Border roads are generally oriented parallel with the border and are used for direct enforcement of the border. Border roads are typically (b) (7)(E) (see **Figure 13, Border Road Typical Section (b) (7)(E) Wide Road**)) and are posted for (b) (7)(E) per hour travel. These roads shall be designed to (b) (7)(E)

(b) (7)(E) New or improved border roads shall be constructed as FC-1, FC-2, or FC-5 roads, depending on operational and funding requirements and project-by-project basis.

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#### **1.1.2 ACCESS ROAD**

Access roads generally provide access from public roads to the border roads and to TI not accessible from a border road. Access roads are typically one-lane roads with pullouts and turnarounds to accommodate two-way traffic. The width of the access roads shall be (b) (7)(E) for one-lane roads (see **Figure 14, Access Road Typical Section (b) (7)(E) Wide Road**)), but shall widen to (b) (7)(E) at curves and points of short sight distance. Access road width and pullout placement shall be designed (b) (7)(E) (b) (7)(E). The maximum width of access roads shall be (b) (7)(E). Access roads may be constructed as any of the four road types identified above depending on operational and funding requirements and project-by-project basis.

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#### **1.1.3 TEMPORARY CONSTRUCTION ROAD**

Temporary construction roads are developed during design or construction solely for construction of TI such as, but not limited to, primary fence. Once designated as temporary construction roads, they may be used during future maintenance activities but shall not be considered border or access roads until they are upgraded to meet the criteria set forth in this document.

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#### **1.1.4 OPERATIONS ROAD**

Operations roads are typically dirt or aggregate roads located on private lands that provide valuable operational mobility for Border Patrol field agents. While operational roads are very similar in function to access roads, they are not covered under these TI Standards due to lack of interest from CBP in owning the road. However, CBP will typically enter into a license agreement with the land owner which allows CBP to conduct minor maintenance on the road due to heavier traffic volume.

## SECTION 2. ROAD PAVEMENT SECTION DESIGN STANDARDS

Pavement section design is dependent on site-specific factors and selected road types identified in **Section 1, Road Types**. Standard pavement section solutions used for CBP border and access roads are discussed in depth in **Sections 2.1, Stabilized Subgrade**, through **Section 2.9, Pavement Section with Cellular Confinement or Mechanical Concrete**. Border and access road pavement design criteria shall conform to the **U.S. Army Corps of Engineers Technical Manual (TM)** (b) (7)(E) ([Reference 1](#), page 35) for flexible and rigid pavements, and (b) (7)(E) ([Reference 2](#), page 35) for aggregate surface roads. All pavement design shall be based on Class F (10 < effective design vehicles per hour < 25), Category IV (traffic containing as much as 25 percent trucks, but with no more than 10 percent of the total traffic composed of trucks having three or more axles) roads as defined in (b) (7)(E) ([Reference 3](#), page 35).

Regardless of the pavement section selected for any particular road type, the road shall be graded in both profile and cross slope to mitigate erosion from drainage run-off. All drainage crossings shall be protected by appropriate measures such as, but not limited to, articulated concrete block or concrete pavement, culverts, roadside ditches or a combination thereof. See **Section 7, Drainage Protection Design Standards**.

### 2.1 STABILIZED SUBGRADE

All border and access road improvements shall require stabilized subgrade. Depth of stabilized subgrade shall be based on the requirements outlined in (b) (7)(E) flexible and rigid pavements and in (b) (7)(E) for aggregate surface pavements. While a design index of 3 could be selected for a Type F, Category IV road, a design index of 4 shall be used for border and access roads subgrade compactions to account for maintenance and construction traffic.

### 2.2 CONCRETE PAVEMENT SECTION (FC-1 AND LOW WATER CROSSINGS)

Concrete pavement section consists of cast-in-place concrete slab driving surface. Typically, this type of surface is used for areas of high traffic or high risk for erosion, such as low water crossings (LWC) and steep profile grades. The concrete slab shall be reinforced by either steel or fiber, and joints shall be placed to control cracking and expansion of the slab. Slab thickness shall be determined per **Chapter 13** of (b) (7)(E), minimum concrete compressive strength of (b) (7)(E) and site-specific soil conditions. Thickened edges shall be required for all concrete pavement sections. Where scour at concrete pavement sections is a concern, concrete turndown walls shall be placed in lieu of thickened edges. Concrete pavement can be installed by military or contractor construction. However, prior to specifying concrete pavement section, consideration must be given to the proximity of the site relative to the concrete batch plant, since concrete is required to be placed within 60 to 90 minutes of batching. Where the workability of concrete prior to placing is a concern, concrete retarders or on-site concrete batching may be specified. Prior to specifying on-site concrete batching, an available water source shall be identified and environmental and real estate compliance shall be

confirmed. In addition, the accessibility to the site by loaded concrete mixer trucks shall be considered in remote and/or mountainous areas prior to specifying concrete pavement section.



**Figure 5 - Concrete Pavement**

In order to maximize the design life for the concrete pavement section, annual inspections should be planned. During such inspections, joints and surface cracking should be inspected for signs of wear and cracking. If any are found, maintenance should include sealing, surface patching and joint repair.

Concrete roads are applicable to FC-1 road types and may be used for LWC. Concrete pavement can also be applied to roads with steep slopes exceeding 15 percent. Concrete pavement shall comply with specifications in **Appendix A, Standard Specifications, 03 30 00 Cast-in-Place Concrete**.

## **2.3 ASPHALT PAVEMENT SECTION (FC-1)**

Asphalt pavement section consists of a layer of asphaltic concrete placed over aggregate base and sub-base courses. The total thickness of the asphalt pavement section shall be determined per **Chapter 8 of (b) (7)(E)** the **California Bearing Ratio (CBR)** ([Reference 4](#), page 35) as recommended by a Civil Engineer with Geotechnical expertise. The thicknesses of the base course and pavement shall be determined per **Chapter 6 of (b) (7)(E)** of base course material that is locally available. Placement of asphalt pavement sections, applicable to FC-1 road type, shall be limited with respect to the steepness of the border road or access road profile grade. See **Section 4.3.1, Profile Grades**, for maximum profile grade to which asphalt should be placed based on industry standards and equipment capabilities.

Asphalt concrete shall be a performance-grade asphalt binder conforming to the requirements of **American Association of State Highway and Transportation Officials (AASHTO)** ([Reference 5](#), page 35) **(b) (7)(E)**. For general asphalt pavement specifications, see **Appendix A, Standard Specifications, 32 10 00 Bituminous Concrete Pavement**.





**Figure 6 – Asphalt Pavement**

Asphalt requires bi-annual inspection for the first 10 years and annual inspection thereafter. Repairs include crack sealing, pothole patching, and other repairing. Milling and resurfacing are typically required every 15 years.

## **2.4 PAVEMENT SECTION WITH SOIL STABILIZATION ADDITIVES (FC-1, FC-2, FC-3, AND FC-5)**

Soil stabilization can be performed with the use of cement or lime additives in order to provide a stronger more durable pavement section. Soil stabilization using cement additives is typically used to improve the surface course of a border or access road to a point to where it is considered an FC-1 or FC-2 road type. Often, soil cement stabilization is selected when steeper road grades are needed (see **Section 4.3.1 Profile Grades**) or where there is a greater potential for drainage across the road that would cause erosion to an FC-2 or FC-3 border or access road. Soil stabilization using lime additives improves native subgrades that have low CBR values. Low subgrade CBR values can lead to poor performance and impact longevity of the road that may not otherwise be considered prone to damage from erosion. Since soil stabilization with lime additives is applied to subgrade, the finished road type can be any of the FC roads identified within the TI design standards. Both cement and lime additives work well for rural, urban, and mountainous areas; however, availability of water should be considered prior to selecting the soil stabilization with cement additives as discussed in **Section 2.4.1, Soil Stabilization with Cement Additive (Soil Cement)**. Placement of soil stabilization with additives shall be limited with respect to the steepness of the border road or access road profile grade. See **Section 4.3.1, Profile Grades**, for maximum profile grade to which surface course stabilization should be placed based on industry standards and equipment capabilities. Soil stabilization with additives shall be designed and proportioned in accordance with the recommendations of **(b) (7)(E)** ([Reference 6](#), page 35) and site specific geotechnical recommendations. For general soil stabilization with additives specifications, see **Appendix A, Standard Specifications, Soil Cement and Lime Stabilization**.

### 2.4.1 SOIL STABILIZATION WITH CEMENT ADDITIVE (SOIL CEMENT)

The mixing of cement additive (and water) to soils can be used to improve TI roads by both in-situ application and surface application methods. For the in-situ application method, water and cement are added directly to the in-situ soils or on-site surface course material and then mixed with heavy equipment such as large tillers. The surface application method involves pre-mixing of the cement, aggregate, and water in a pug mill or at an off-site plant, subsequent transportation to the site of the application, and application with grading equipment and compactors. Both soil cement methods require compaction with heavy, rubber-tired rollers. Seven days of curing time is recommended before heavy traffic on any road constructed with soil cement. Soil cement mix design shall have a Plasticity Index (PI) that is (b) (7)(E)

. Prior to selecting soil cement, a Civil Engineer with Geotechnical expertise shall evaluate native soil conditions to ensure properties are conducive to placement of cement. Soil types with high clay content or organics will affect the cement strength thus do not work well with either of the soil cement application methods. Availability of water shall also be considered when determining the applicability of soil cement. Similar to placement of concrete, water is a key component for both soil cement application methods. While mixing of soil cement off-site then utilizing the surface application method will reduce the amount of water needed on-site, as compared to mixing on-site with a pug mill or the in-situ application method, the amount of water needed shall be evaluated prior to selecting soil cement.

Maintenance of soil cement treated roads requires bi-annual inspections. When repairs to cracking and potholing are required, they must be completed with full-depth surface replacement using either soil cement or concrete. No skin patches are permitted. The benefit of using cement rather than lime stabilization, discussed in **Section 2.4.2, Soil Stabilization with Lime Additives (Lime Stabilization)**, is that cement is typically less susceptible to erosion if designed and applied properly.



**Figure 7 – Soil Stabilization with Additives**

#### 2.4.2 SOIL STABILIZATION WITH LIME ADDITIVES (LIME STABILIZATION)

The addition of lime to soils can be used to improve border and access roads by stabilizing native subgrade materials. Since lime stabilization does not provide a rigid pavement similar to soil cement, it should only be used as subsurface treatment. By injecting lime into native soils, the subgrade soil CBR can be increased thus allowing for a reduced thickness in the selected surface course application. Lime works similarly to soil cement but is used in conditions in which native soils are particularly clayey, with PI greater than 12. However, lime treated soils are easier to repair than soil cement applications, especially when used in conjunction with aggregate surface course or grade dirt roads, since there is no need to remove entire pavement sections. If road maintenance is noted to be requiring more general blading to remove ruts and rough patches, lime can be directly injected to the subgrade through the in-place surface course. Lime shall be (b) (7)(E)

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

#### 2.5 AGGREGATE SURFACE COURSE PAVEMENT SECTION (FC-2, FC-5)

Aggregate surface course roads work well for rural, urban, and mountainous areas. No special equipment is required, and construction can be completed using standard equipment such as excavators, graders, and water trucks. The thickness of the aggregate surface course shall be determined according to **Figure 1** (b) (7)(E) as recommended by a Civil Engineer with Geotechnical expertise. The thickness of aggregate surface course shall be placed over prepared subgrade, which could simply be compacted native material, scarified and compacted native material, or possibly imported select material based on site-specific geotechnical recommendations. Aggregate surface course is applicable for FC-2 and FC-5 roads. If aggregate surface course is applied to FC-5 roads, cellular or mechanical concrete sub-surface treatments are required. See **Section 2.9, Pavement Section with Cellular Confinement or Mechanical Concrete**, for cellular confinement and mechanical concrete application. See **Section 4.3.1, Profile Grades**, for maximum profile grade to which aggregate surface course pavement sections should be placed due to concerns of erosion and lack of traction. Performance of aggregate surface course roads is dependent on the gradation and quality of the surface course, proper grading of the road to provide adequate drainage, and regular maintenance.

Aggregate surface roads require annual inspections with supplemental inspections after storm events. Repairs and maintenance include blading to remove ruts or wash-boarding and placing additional material as needed. The level of maintenance depends upon the use of the road and the impact of drainage conditions on the surface.



Figure 8 – Aggregate Surface Course Road

## 2.6 CHIP SEAL PAVEMENT SECTION (FC-1, FC-2)

Chip seal is a thin layer of aggregate and asphalt placed on compacted aggregate base course. Two coats of chip seal are required. After each coating, the surface is rolled and compacted. Chip seal provides a sealed surface but does not provide structural strength so it can be cost effective on roads where dust mitigation or water infiltration into the base or subgrade requires control. In addition, chip seal can be used to repair minor cracks in asphalt pavement. Chip seal pavement section shall be designed and specified according to the **California Department of Transportation (Caltrans) Maintenance Technical Advisory Guide, Chapter 5** ([Reference 7](#), page 35). Placement of chip seal, applicable to FC-1 and FC-2 road types, shall be limited with respect to the steepness of the border road or access road profile grade. See **Section 4.3.1, Profile Grades**, for maximum profile grade to which chip seal should be placed based on industry standards and equipment capabilities. For general chip seal specifications, see **Appendix A, Standard Specifications, 32 01 00 Bituminous Seal**.



Figure 9 - Chip Seal



Inspections are required annually. Repairs include crack sealing with use of hot tar and sand, filling potholes with cold patch, or pulverize and re-apply the chip seal for segments needed. Re-application is estimated to be needed every 6-10 years.

## 2.7 PAVEMENT SECTION WITH POLYMER BLEND RESIN (FC-2, FC-5)

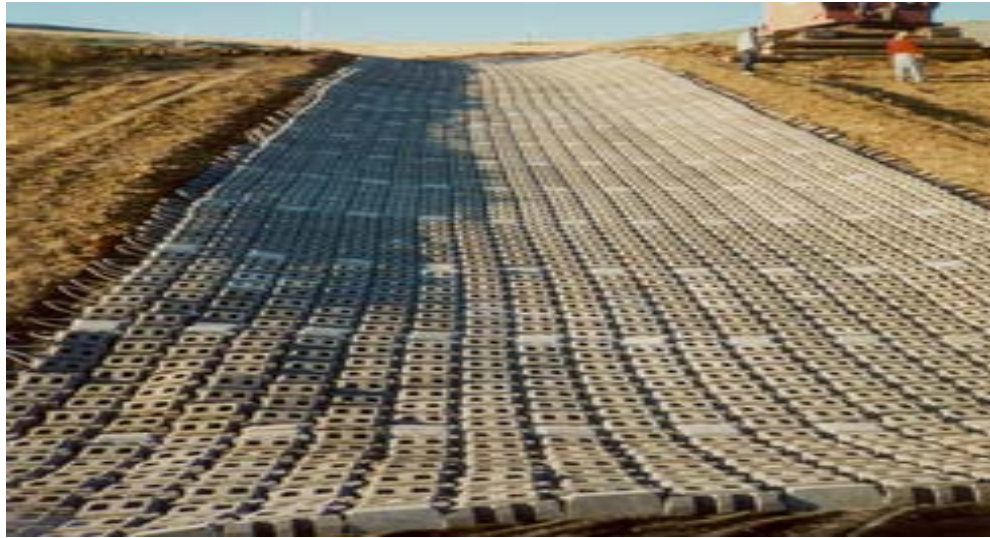
Aggregate and dirt road pavement sections treated with polymer blend resin can be an effective technique for dust control and increasing the CBR of dirt roads. For dust control treatments, the polymer blend is mixed with aggregate and placed on compacted soil sub-base material. An armor coat, consisting of a polymeric emulsion, is then sprayed on the compacted surface course and allowed to cure. If the armor coat is mixed on-site, a water source will be required. If access to water is a concern, the armor coat can be mixed off-site and then applied to the surface. For areas where native material CBR is low, the polymer blend resin can be mixed with the soils to increase the sub-grade CBR. Placement of polymer blend resin, suitable for FC-2 and FC-5 road types, shall be limited with respect to the steepness of the border road or access road profile grade. See **Section 4.3.1, Profile Grades**, for maximum profile grade to which polymer blend resin should be placed based on industry standards and equipment capabilities. For general polymer blend resin specifications, see **Appendix A, Standard Specifications, 32 12 18 Resin Modified Pavement Surfacing Material**.

Inspections are required bi-annually. Repairs of potholes and worn areas require full depth repairs and re-application of the polymeric emulsion top coat is required for dust control.

## 2.8 ARTICULATED CONCRETE MAT PAVEMENT SECTION

Articulated concrete mats are typically used for LWC but can also be applied as a road surface in areas susceptible to significant erosion. Articulated concrete mats are a flexible, interlocking matrix of machine-compressed, cellular concrete blocks of uniform size, shape, and weight used for hard armor erosion control. These blocks are laced longitudinally with galvanized steel, stainless steel, or polyester revetment cables to provide ease of handling and rapid installation. Each concrete block unit shall have a compressive strength of (b) (7)(E). Mats vary in dimensions but are typically (b) (7)(E). Articulated concrete mats are excellent for urban, rural, and mountainous locations due to its ease of transport and installation. Mats are pre-assembled so there is no time limit on placement. In addition, there is no water or mixing requirements beyond what is required for subgrade preparation. Placement of articulated concrete mats, suitable for FC road types, shall be limited with respect to the steepness of the border road or access road profile grade. See **Section 4.3.1, Profile Grades**, for maximum profile grade to which articulated concrete mats should be placed based on industry standards and equipment capabilities. For general articulated concrete mat specifications, see **Appendix A, Standard Specifications, Articulated Concrete Mat**.

Maintenance requires bi-annual inspections, (b) (7)(E)



**Figure 10 - Articulated Concrete Mat**

## **2.9 PAVEMENT SECTION WITH CELLULAR CONFINEMENT OR MECHANICAL CONCRETE**

Cellular confinement or mechanical concrete is recommended for soft soils with low CBR, such as sand or silt roads on which thick, sinking material makes driving difficult or impossible. Cellular confinement consists of a three-dimensional, multi-celled structure, similar to a honey-comb, in a mat form. Loads are distributed laterally and vertical deflection is reduced. Construction requires anchoring at regular intervals and backfilling the cells with approved on-site materials. Compaction should be performed with a roller or lightweight compaction equipment. Mechanical concrete, similar to cellular confinement, utilizes larger cells, such as used tires with the side walls removed, placed adjacent one another. The cells are then filled with crushed aggregate which together with the cells forms the hardened road sub-base. Prior to selecting cellular confinement or mechanical concrete, a determination should be made on the source of the fill material within the cells and whether it can be acquired on-site or will be required to be shipped in from off-site. Regardless of the system selected, a gravel surface layer of at least 4 inches should be placed above the cellular confinement or mechanical concrete. Cellular confinement and mechanical concrete are good for urban, rural, and mountainous locations and are easy to transport and install. Cellular confinement and mechanical concrete are suitable for all road types but are recommended for FC-5 roads in particular. Placement of cellular confinement and mechanical concrete shall be limited with respect to the steepness of the border road or access road profile grade. See **Section 4.3.1, Profile Grades**, for maximum profile grade to which cellular confinement and mechanical concrete should be placed based on industry standards and equipment capabilities. General specifications for cellular confinement are provided at the end of **Appendix A, Standard Specifications**. Mechanical concrete is currently a registered trademarked item, therefore a draft vendor specification that outlines materials and execution is provided **Appendix A, Standard Specifications** for consideration by the designer.

Maintenance for both cellular confinement and mechanical concrete requires bi-annual inspection and blading of the surface material to remove any ruts or wash-boarding. New material should be added every two years or as needed to maintain the 4 inches of gravel surface material.



**Figure 11 - Cellular Confinement**



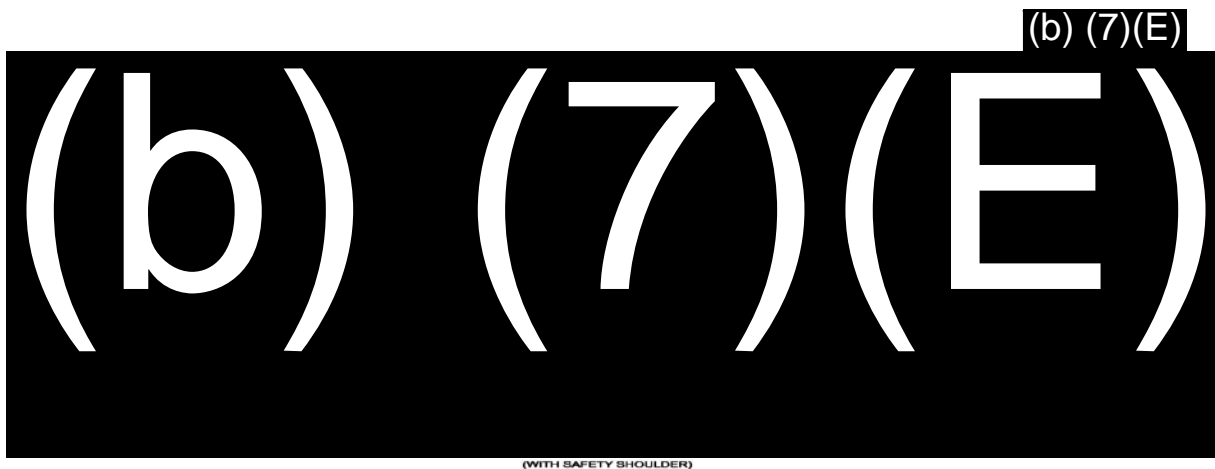
**Figure 12 – Mechanical Concrete**

### SECTION 3. ROAD CROSS SECTION DESIGN STANDARDS

The typical cross section for border road new construction or improvements shall (b) (7)(E) (b) (7)(E) on each side. Based on project specific operational need, (b) (7)(E) (b) (7)(E) safety shoulder may be placed on the (b) (7)(E) side of the border road. Where the safety shoulder is required, the (b) (7)(E) wide nominal shoulder shall not be required.

The typical cross section for access road new construction or improvements shall be (b) (7)(E) and have pull outs spaced based on sight distance and operational need in order to provide room for passing or parking for foot pursuit. At curves and blind spots where sight distance for on-coming traffic is restricted, the access road shall widen to (b) (7)(E).

All border and access roads and associated shoulders shall be graded to allow stormwater run-off to drain away from fence and other TI. See **Figures 13, Border Road Typical Section (b) (7)(E) Wide Road)**, and **Figure 14, Access Road Typical Section (b) (7)(E) Wide Road)**, for examples of typical road sections for a border road and an access road. Earthwork shall comply with the specifications in **Appendix A, Standard Specifications, (b) (7)(E) Earthwork, (b) (7)(E) Clear and Grub, and (b) (7)(E) Grading.**



**Figure 13 - Border Road Typical Section (b) (7)(E) Wide Road)**



**Figure 14 - Access Road Typical Section (b) (7)(E) Wide Road)**



### 3.1 CROSS-SLOPE

In general, whether the road is crowned or superelevated, all cross slopes shall be (b) (7)(E) or greater. Typically (b) (7)(E) shall be the maximum cross slope, however, this shall be evaluated by the designer based on site specific conditions. Where profile grades exceed (b) (7)(E) for aggregate surface course roads, the minimum cross slope for crowned or superelevated roads shall be increased to (b) (7)(E) to allow for more efficient drainage conveyance off the road. Typically, border roads should be crowned in order to convey drainage run-off to each side of the road. However, there are exceptions that shall warrant superelevated road cross sections. These include the needs to safely and comfortably negotiate horizontal curves (see **Section 4.2.2, Superelevation**, for superelevation guidelines) and to accommodate roadway drainage outlet conditions so to protect structures and TI. Access roads, which are typically (b) (7)(E) shall be superelevated only. Crowning of access roads may be used where access roads are widened over considerable distances and drainage considerations recommend the use of a crown.

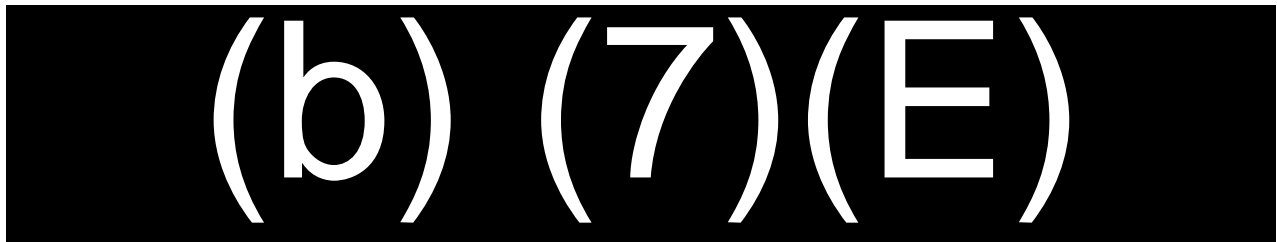
### 3.2 SAFETY SHOULDER

Border roads may have an additional safety shoulder added to the road section (b) (7)(E)

Safety shoulders shall be constructed of compacted native material and shall have a minimum cross slope of (b) (7)(E). Prior to the start of all border road projects, the necessity of a safety shoulder shall be evaluated. Access roads typically do not require safety shoulders.

### 3.3 FORESLOPE & GUARDRAIL

Road foreslopes are the slopes beyond the road shoulder that contain the road section and embankment. When a road is constructed entirely using fill, the foreslope transitions the road embankment back into natural ground. When a road is constructed using cut, the foreslope must be transitioned to a backslope and before it ties into natural ground. See **Figure 15, Foreslope & Backslope**, for an illustration of the two slopes.



**Figure 15 – Foreslope & Backslope**

Guardrails are needed where vehicles accidentally leaving the roadway might be damaged and driver safety is put in jeopardy. Typically the need for guardrail is governed by the height and grade of the fore slope. From **Figure 3-2 in (b) (7)(E)** a road with fore slopes less than **(b) (7)(E)** at any grade and fills at any height with fore slope grade at **(b) (7)(E)** or less typically do not require guardrail. However, these limits should always be evaluated against site specific reasons and Engineering judgment that may ultimately dictate the need for guardrail. For a full range of scenarios that require guardrail, see **Figure 3-2 in (b) (7)(E)**

## SECTION 4. ROAD GEOMETRIC DESIGN STANDARDS

In mountainous areas, the horizontal alignment should be designed in conjunction with a vertical alignment to provide the most direct route to meet CBP operational requirements with the least amount of earthwork. In addition, for border and access roads through mountainous areas, the feasibility of switchbacks and the use of ridge lines shall be evaluated.

### 4.1 SIGHT DISTANCES

Proper sight distances are critical for both safety and security reasons. The minimum stopping sight distance for safely avoiding a stationary object in the road is (b) (7)(E). This distance assumes that the height of the eye of the driver is (b) (7)(E) above the road surface and that the height of an object to be observed is (b) (7)(E) above the road surface. The minimum passing sight distance for avoiding a moving on-coming object in the road is (b) (7)(E) feet. Passing sight distances assume that the height of the eye of the driver is (b) (7)(E) above the road surface and the height of a vehicle traveling in the opposite direction is (b) (7)(E) above the road surface. In order to meet the required stopping and passing sight distances, the designer shall select road vertical curves that meet the distance criteria stated above. A posted speed limit of (b) (7)(E) per hour shall be used for all sight distance evaluations. **Figure 16, Sight Distance**, illustrates the heights associated with stopping and passing sight distances.

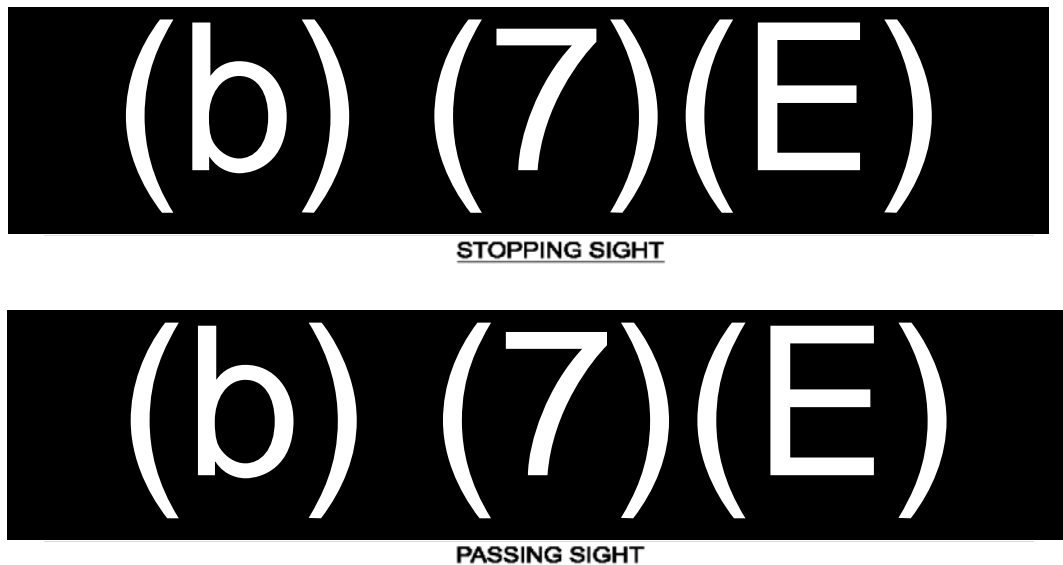


Figure 16 - Sight Distance

### 4.2 HORIZONTAL ALIGNMENT

The horizontal road alignment, in conjunction with the vertical road alignment, shall be balanced to meet a combination of safety, CBP operational requirements, and best engineering practices while considering environmental limitations and local land manager concerns. When developing the horizontal alignment, horizontal curves and roadway superelevation shall be considered.

#### 4.2.1 HORIZONTAL CURVES

Traveling a road with a tighter radius will reduce the design speed and increase the risk of vehicle rollover and crashes. Border and access road maximum horizontal curvature shall adhere to the design restrictions for the horizontal curvature of roads provided in **(b) (7)(E)** Chapter 5, Table 1-1 for a Class F road as shown below in Table 1, **Horizontal Curves**. The angle at maximum curvature is illustrated in Figure 17, **Maximum Curvature**. However, the maximum curvature does not consider the minimum radius required for horizontal line of sight as discussed below.

Class F Road			
Design Controls and Elements	Flat	Rolling	Mountainous
Maximum Horizontal Curvature	(b) (7)(E)		

Table 1 - Horizontal Curves

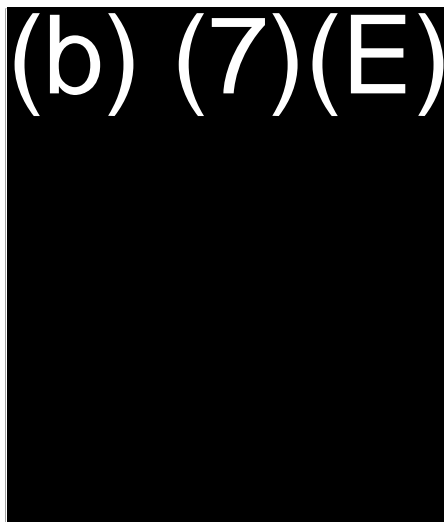


Figure 17 - Maximum Curvature

Prior to finalizing the horizontal curve design, the angle of curvature shall be evaluated at known horizontal sight obstructions to ensure the horizontal curvature provided is no less than the stopping sight distance required. See Figure 18, **Horizontal Sight Distance**, for an illustration.



Figure 18 - Horizontal Sight Distance

**Texas Department of Transportation (TXDOT) Roadway Design Manual** ([Reference 8](#), page 35) provides an equation for calculating the length of the middle ordinate to verify the horizontal curve provided meets stopping distance requirements.

$$M = R*(1 - \cos(28.65S/R))$$

Where:

M = Middle Ordinate (feet)

S = Stopping sight distance (feet)

R = Radius of the curve (feet)

#### 4.2.2 SUPERELEVATION

For roads with a horizontal curve, superelevation shall be evaluated to increase safety and driver comfort. Superelevation is the increase in cross-slope above the normal design slope. This is done by raising the outer edge of the road in the curve.

**(b) (7)(E)** page 35) provides guidelines for all superelevation design. **Table 2, Maximum Superelevation (b) (7)(E) Design Speeds & Horizontal Curves**, is a summary of interpolated values for maximum superelevation, minimum radius and maximum degree of curve from **Table 2-5** in **(b) (7)(E)** design speed.

Maximum Superelevation	Minimum Radius	Maximum Degree of Curve
Foot per Foot	Feet	Degrees
<b>(b) (7)(E)</b>		

**Table 2 – Maximum Superelevation (b) (7)(E) Design Speeds & Horizontal Curves**

### 4.3 VERTICAL ALIGNMENT

The vertical alignment for all roads should minimize the volume of necessary earthwork while adhering to the maximum curvature and slope requirements. Attention shall be given to proper drainage when altering the surface elevations. Where profiles exceed the limits, switchback installations or alternative alignments shall be evaluated in order to bring the longitudinal profile slopes within acceptable range. Where real estate concerns restrict the use of switchbacks as means to control longitudinal profile, special attention shall be given to the selection of pavement section and the installation of signage, guardrail, and other safety measures.

#### 4.3.1 PROFILE GRADES

Maximum road profile grades are taken from “**Low Volume Roads Engineering Best Managements Practices Field Guide**,” prepared by the **U.S. Department of Agriculture Forest Service** ([Reference 10](#), page 35). The recommended maximum profile grade for border roads is 12 percent. The recommended maximum profile grade

for access roads is (b) (7)(E). In order to maintain the recommended maximum profile grades through mountainous terrain, the use of switchbacks and extensive cut-and-fill operations will need to be compared against environmental and real estate constraints. Switchbacks should only be used when the maximum profile grade is not exceeded in the switchback alignment and the critical length can be maintained. The critical length is the distance between tangents of horizontal curves on the switchbacks. **Figure 19, Switchback Design**, illustrates the use of these terms in design of switchbacks. The recommended minimum profile grade for all roads is (b) (7)(E). If lesser percent profile grades are required, the need for additional drainage control shall be evaluated. The maximum grade break for border and access roads shall be (b) (7)(E).

The maximum profile grades recommended above correspond to dirt and aggregate-surfaced road types. If a steeper slope is required to reduce the amount of cut-and-fill or gain the critical length needed for a switchback, the surface shall be constructed of cement stabilized aggregate or concrete pavement section. The maximum slope for any such border road or access road in order to maintain safety and vehicle accessibility shall be (b) (7)(E). For general upper end slope restrictions for all pavement section improvements discussed in this section, see **Table 3, Maximum Recommended Profile Grade by Pavement Type**.

Pavement Section	Maximum Recommended Profile Grade
Concrete	(b) (7)(E)
Asphalt	(b) (7)(E)
Soil Cement	(b) (7)(E)
Lime Stabilization	(b) (7)(E)
Aggregate Surface Course	(b) (7)(E)
Chip Seal	(b) (7)(E)
Polymer Blend Resin	(b) (7)(E)
Articulated Concrete Mat	(b) (7)(E)
Cellular Confinement or Mechanical Concrete	(b) (7)(E)

**Table 3 – Maximum Recommended Profile Grade by Pavement Type**

Certain risks and necessary measures are associated with increasing the profile grades beyond (b) (7)(E). These include the following:

- The road shall be closed to the public permanently and signs must be installed on these segments indicating the steep road grade conditions
- Proper signage must warn drivers of the need for four-wheel drive vehicles
- There is a level of risk to drive on the roads if they are not properly maintained with correct moisture content, compaction, and surface protection (such as a dust palliative)
- The speed will be reduced (b) (7)(E) or less on the steep segments and curves.

Concrete roads on grades exceeding (b) (7)(E) shall include keys across the full width of the road and spaced at regular intervals along the road, to resist sliding and buckling under vehicle loads. The keys shall be a minimum of (b) (7)(E) deep.

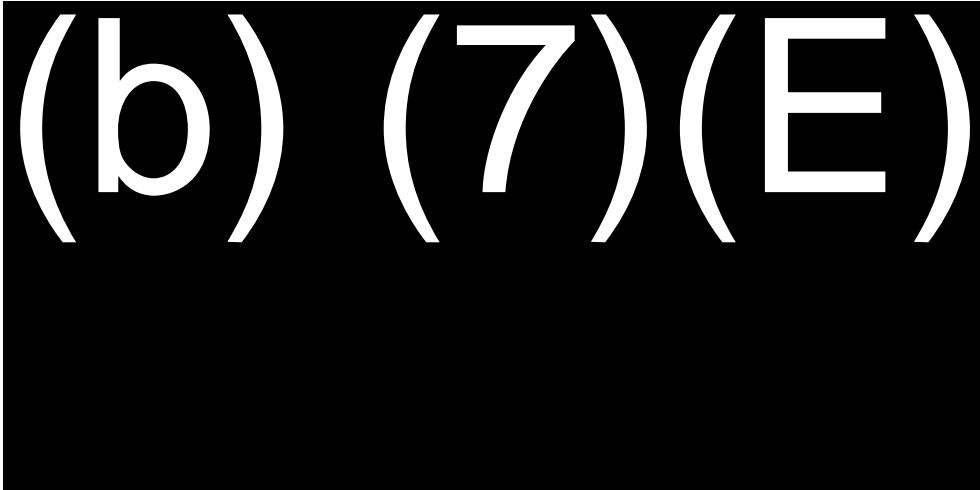


Figure 19 - Switchback Design

#### 4.3.2 MINIMUM K VALUES

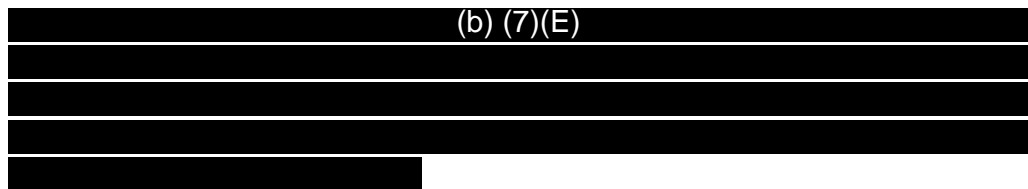
The rate of vertical curvature is called the K value. This is a unit-less value that represents the ratio of the length of a vertical curve between vertical points of curvature (VPC), L, in feet, to the algebraic change in grades, A, percent. K values are used to provide limits to the severity of a vertical curve and to provide proper sight distance. An illustration of K values is shown in **Figures 20, Large Coefficient of Vertical Curvature, K**, and **Figure 21, Small Coefficient of Vertical Curvature, K**. **Figure 20** indicates a large K value, a smooth transition that provides good sight distance. **Figure 21** indicates a small K value, a sharp transition with poor sight distance.



Figure 20 - Large Coefficient of Vertical Curvature, K

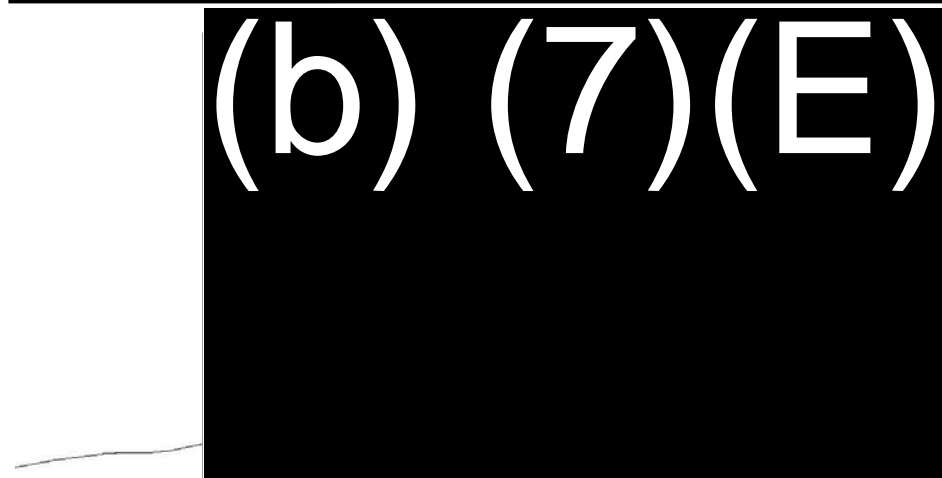
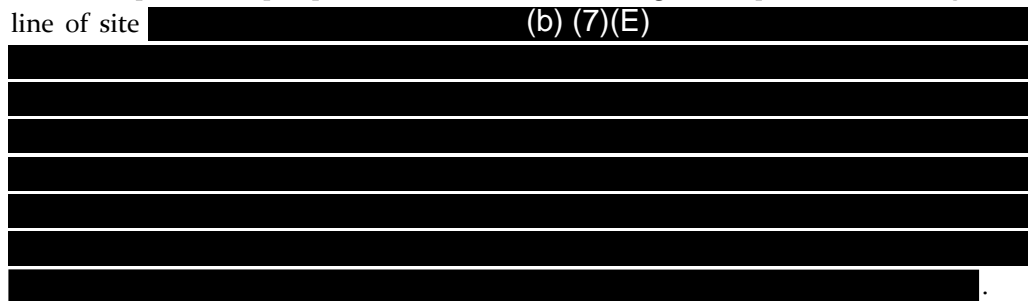


**Figure 21 -Small Coefficient of Vertical Curvature, K**



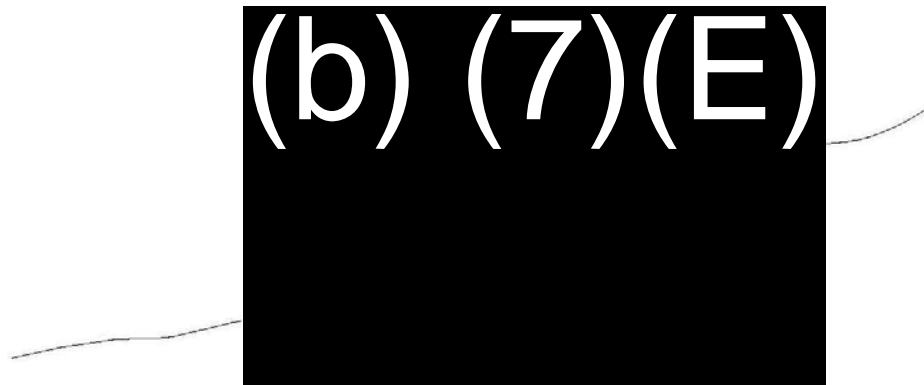
#### **4.3.3 STAND-OFF DISTANCES**

From an operational perspective, Border Patrol field agents require a reasonably clear line of site



**Figure 22 - Stand-Off Distance with Fence to South**





**Figure 23 - Stand-Off Distance with No Fence to South**

In addition to operational requirements for stand-off distances adjacent to road cut slopes, the designer shall also evaluate slope stability of the cut slope and rock fall potential. Evaluations shall be made based on Geotechnical exploration, testing and recommendations for the border or access roads. Based upon the Geotechnical recommendations, the designer shall alert CBP to any necessary roadside rock fall protection requirements not already included as part of the border or access road design.

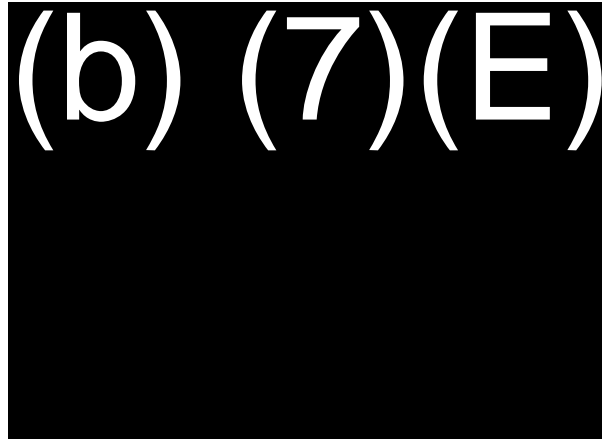
#### 4.4 DESIGN SPEED

The posted speed for border roads shall be (b) (7)(E) per hour. The posted speed for access roads shall be (b) (7)(E) per hour. Road capacity should be designed according to all safety standards described in this document and in (b) (7)(E).

#### 4.5 INTERSECTIONS

Intersections should have an optimum angle of (b) (7)(E) with a minimum of (b) (7)(E) to either direction. See **Figure 24, Intersection Angle Limitations**, for an illustration. (b) (7)(E)

(b) (7)(E). Stop or yield signs types shall be installed according to the **Section 5, Signage Design Standards**. The slopes through intersections should be between (b) (7)(E).



**Figure 24 - Intersection Angle Limitations**

#### 4.6 TURNAROUNDS & PULLOUTS

Turnarounds and pullouts are necessary to allow the safe passage of vehicles during patrol operations and maintenance activities. When roads are designed to be less than (b) (7)(E) wide, a pullout shall be required. Pullouts shall be placed at locations and intervals based on both vertical and horizontal sight distance. Pullouts for straight stretches of road shall be placed at quarter-mile maximum intervals. The minimum length of a single pullout shall be (b) (7)(E). A Turnaround is needed at (b) (7)(E). The shape of the turnaround can be circular, circular-offset, L-type, T-type, Y-type, or branch type, per **Figure V-2**, in (b) (7)(E). The minimum radius for a circular turnaround is (b) (7)(E) with a minimum road width of (b) (7)(E). Where border or access roads are less than (b) (7)(E), the transition length between typical road sections to turnaround section shall be between (b) (7)(E). Road turnarounds and pullouts shall be evaluated based on the AASHTO design vehicles noted below (P – passenger vehicle, SU – single unit truck, WB-40 – midsize semi trailer, and W8-50 – full size semi trailer) and CBP traffic requirements (Patrol Vehicles only, patrol vehicles and maintenance vehicles, etc.) See **Figure 25, Turnarounds**, for examples of Turnarounds.

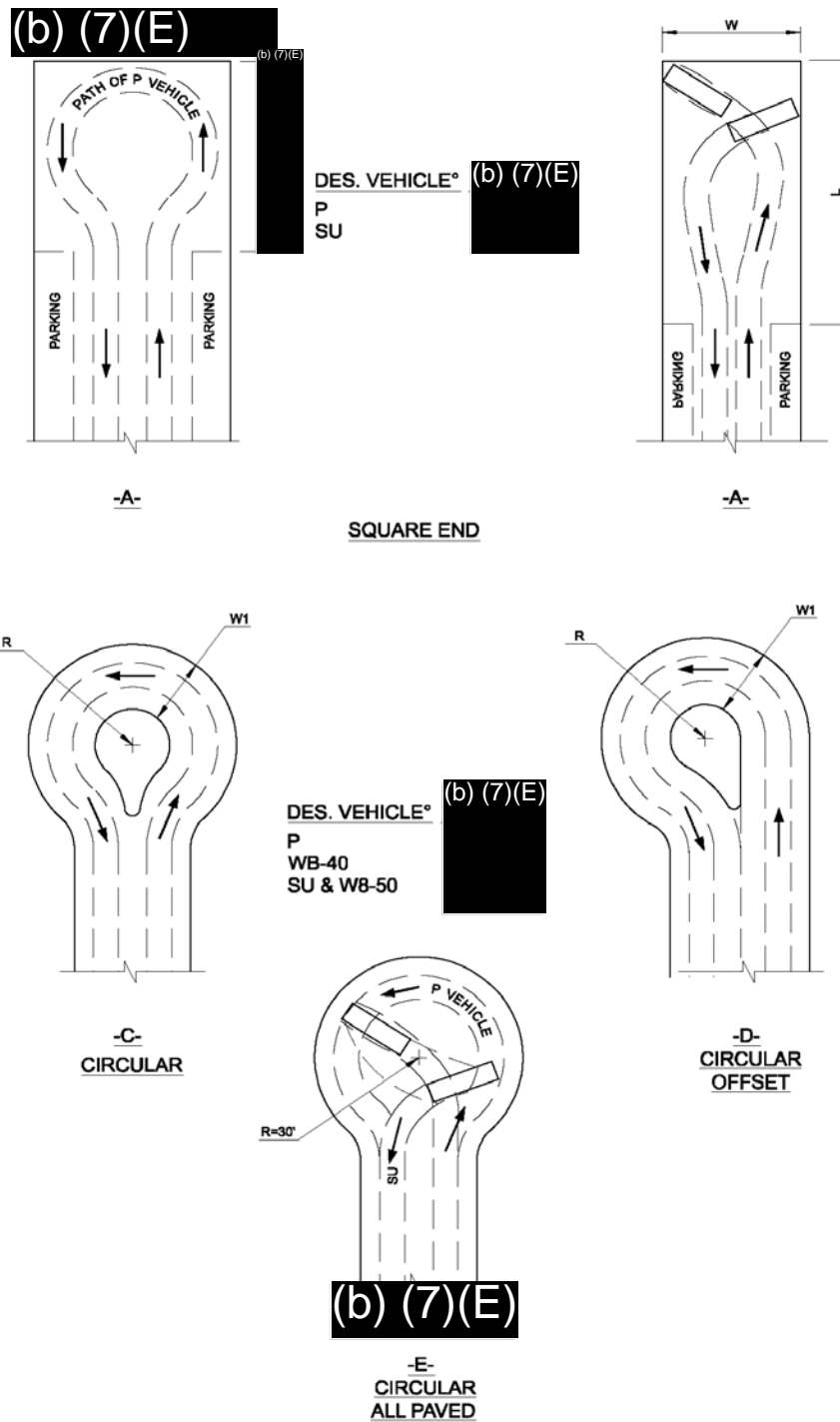


Figure 25 – Turnarounds

## SECTION 5. BRIDGE DESIGN STANDARDS

Where border or access roads are required to cross challenging terrain or large drainage crossings, bridges may be considered by CBP as a viable means to accomplishing the operational objective. Various bridge types that have been designed and/or constructed for CBP include: Bailey trussed bridge (see **Figure 26, (b) (7)(E)**), prestressed box beam bridge, concrete slab bridge, wood trestle bridge and rail car bridge.

Bridges designed for CBP border and access roads shall be governed by the Design code shall be the **AASHTO Standard Specifications for Highway Bridges, 17th Edition - 2002** including all published addendums. The following minimum design standards shall apply:

- Minimum live load design vehicle shall be an HS-20 loading in order to account for maintenance and construction traffic.
- Sidewalks are not required.
- The overall bridge width shall be wide enough to accommodate **(b) (7)(E)**.
- Bridges shall have barriers at each edge of deck with a minimum height of **(b) (7)(E)**.
- Aesthetic applications are not required.

When selecting the bridge type for TI design, the designer shall produce a bridge design selection report (BDSR). The BDSR shall discuss and evaluate at least two superstructure alternatives and two sub-structure alternatives. The evaluation shall include such items as ability to meet operational need, material availability, constructability, immediate costs and life cycle costs. The report shall provide a final recommendation for the bridge selection based on the items mentioned above and be submitted to CBP for review and approval.

Once the bridge type is selected, the designer shall follow industry standards for production of bridge plans, details, specifications and cost estimating.



**Figure 26 - (b) (7)(E)**

## SECTION 6. SIGNAGE DESIGN STANDARDS

Signage for all roads is needed, but the levels of signage depend upon whether the road is for public use or non-public use. FC-1, FC-2, FC-3, and FC-5 roads, if for public use, shall adhere to all standards listed in the **Manual for Uniform Traffic Control Devices (MUTCD)** ([Reference 12](#), page 35).

Roads for non-public use shall have fewer signs, but all signage used shall conform to the size, shape, and color requirements described in MUTCD. The spacing and placement of signs will vary by the situation and project.

All roads shall have obstacle markers for all culvert crossings, drainage structure crossings, and any other hazards adjacent to the road. Obstacle markers shall be reflective and shall be placed so that they may be seen from both traffic directions. For drainage crossings with geometry requiring a slower speed, warning signs shall be placed at each end indicating the suggested speed limit through the crossing.

All roads shall have speed limit signs posted at regular intervals. It is noted that in certain conditions such as pursuit, agents may exceed the posted speed limits to execute their duties.

Signage for steep grades, rolling hills, LWC, and sharp turns shall be installed on all roads as needed.

Examples of all types of signs are included in **Appendix E, Signage Details**.

Passing zones shall be determined based on speed limits, sight distances, and stopping distances according to AASHTO and MUTCD requirements.

## SECTION 7. DRAINAGE PROTECTION DESIGN STANDARDS

Any alteration to existing conditions requires consideration of drainage effects as they relate to the installation or improvement of border roads, access roads, or signage. Border roads, access roads, and signage shall be protected from erosion due to stormwater run-off, and they shall allow the conveyance of stormwater run-off across the site. Design storms that shall be used for sizing erosion protection and conveyance measures are discussed in **Section 7.2, General Drainage** and **Section 7.3, Low Water Crossings**. In addition, any roads constructed or improved within the Roosevelt Reservation, or 60 feet north of the land border, as well as any roads constructed within the Rio Grande and Colorado River floodplains, are required to comply with various border-related treaties between the U.S. and Mexico. It is assumed that if construction roads are needed they would be returned to pre-existing conditions and therefore would not permanently affect existing drainage patterns and not be required to be designed to the drainage standards presented herein. However, if the construction road is intended to remain, it shall adhere to cross-boundary drainage requirements as described in **Section 7.2, General Drainage**.

### 7.1 USIBWC FLOODPLAIN

The U.S. Section of the International Boundary and Water Commission (USIBWC) is responsible for ensuring that improvements on the U.S. side of the international border with Mexico comply with treaty provisions as they relate to impacts to the floodplain of the Rio Grande and Colorado River. All new or improved TI constructed within the Colorado River or Rio Grande floodplains are required to comply with such treaty provisions. To be specific, the impact of all new or improved TI within the Rio Grande and Colorado River floodplains shall be evaluated with respect to change in water surface elevation and deflection across the border. Rise in water surface elevation shall not exceed 6 inches in rural areas and 3 inches in urban areas, and deflection relative to pre and post construction conditions shall be less than 5 percent +/- either way. To verify the impacts are within the above mentioned limits, hydraulic model(s) shall be developed. The model(s) shall be developed with software such as HEC-RAS or FLO2D using USIBWC flow rate and existing condition cross section (provided by USIBWC) and compared with proposed conditions model(s). The proposed condition models shall demonstrate that the impacts of proposed structures to be built within the floodplain will not exceed the rise in water surface elevation and deflection limits stated above. As part of the design process, the designer shall seek USIBWC input relative to the specific hydraulic model software to be used and key model related assumptions.

### 7.2 GENERAL DRAINAGE

The methodology for determining hydrologic flows outside the Rio Grande and Colorado River floodplains shall be based on local county or state drainage manuals or design standards. At a minimum, the following design standards shall be used:

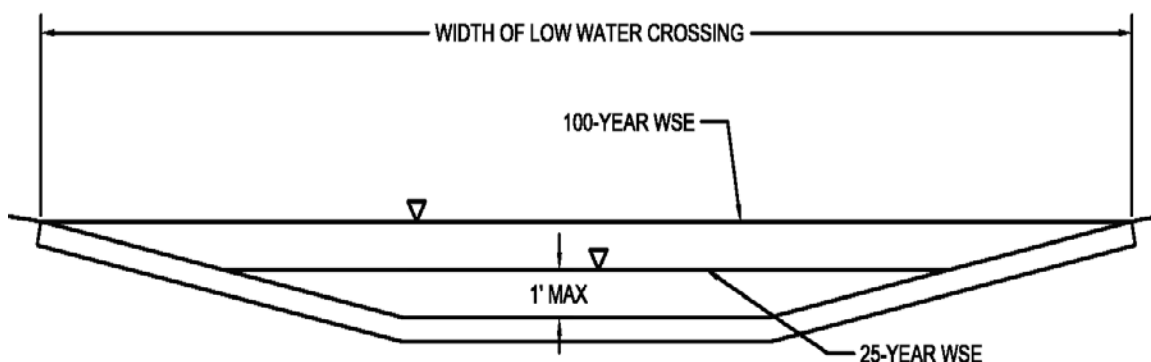
- For watersheds less than 1 square mile, the rational method shall be used.
- For watersheds between 1 square mile and 10 square miles, the [REDACTED] (Reference 13, page 35) method shall be used.

- For watersheds larger than 10 square miles, the regression equations for the area shall be used. These equations are provided by the (b) (7)(E) (Reference 14, page 35). Gauges or flow rate measurements can also be used if data is available and provided by USGS.

All-weather roads, roadside ditches, and rip-rap requirements shall be designed for the 25-year storm event. LWC and culverts shall be sized for the 50-year storm event for rural areas and 100-year storm event in urban areas. Similar to overseeing compliance of construction within the Rio Grande and Colorado River floodplains, USIBWC is also responsible for ensuring that improvements on the U.S. side of the international land border with Mexico comply with treaty provisions as they relate to cross-border drainage. Impact to water surface elevation between the pre and post construction conditions due to any new TI, including border and access roads, being built along the land border between the U.S. and Mexico shall not exceed 6 inches in rural areas and 3 inches in urban areas using the 100-year storm event as required by USIBWC. Similar to the floodplain analysis described in **Section 7.1, USIBWC Floodplain**, drainage crossings shall be modeled with software such as HEC-RAS to show that impacts due to new construction do not cause water surface elevation to rise more than stated above. However, unlike the floodplain analysis described in **Section 7.1, USIBWC Floodplain**, USIBWC will not provide drainage crossing cross sections along the land border. TI new construction or improvements outside the Roosevelt Reservation, or 60 feet north of the border, do not need to comply with the drainage treaty provisions mentioned above.

### 7.3 LOW WATER CROSSINGS

LWC shall have positive drainage and not have more than 6 inches of standing water after any storm event. The extents of LWC shall be determined based on the 50-year storm event water surface elevation (WSE) for rural areas and the 100-year storm event WSE for urban areas. LWC geometry should be designed to allow a depth of no more than 1 foot of water during the 25-year storm event. An example of this design is shown in **Figure 27, Low Water Crossing and Design Storms**. Design analysis shall be completed to determine if safe vehicle passage can be accomplished through 1 foot of water with the anticipated flow velocities. If it cannot be shown that the weight of a patrol vehicle can withstand the force of the drainage flow, then appropriate signage shall be placed warning drivers to not enter when flooded.



**Figure 27 – Low Water Crossing and Design Storms**

A minimum invert width of (b) (7)(E) shall be provided to allow vehicular passage. The maximum longitudinal grade-break between the invert and side slopes of a LWC shall be 5 percent. This avoids scraping of vehicle bumpers as a vehicle traverses the LWC. LWC shall consist of either reinforced concrete or articulated concrete mat. Articulated concrete mats shall be a minimum of 1 foot thick and concrete shall have a minimum slab thickness of 6 inches. All LWC shall have reinforced concrete turn-down walls, or some other means of permanent scour protection, and shall be provided around the entire perimeter to depths required to protect against scour.

## 7.4 CULVERTS

Culverts crossing roadways shall be constructed of reinforced concrete pipe (RCP); all other culverts may be constructed of either corrugated metal pipe (CMP) or RCP. Large volumes of water may require the use of concrete box culverts. Each Border Patrol southwest border Sector requires specific culvert standards and sizes. See **Table 4, Culvert Standards by CBP Sector**, for the source standards for each Sector.

CBP Sector	Culvert Standards
San Diego/ El Centro	Caltrans Drainage standards
Yuma/ Tucson	ADOT Structures standards
El Paso	TxDOT and NM Luna County standards
Big Bend/Del Rio/Laredo/RGV	TxDOT culvert and drainage standards

**Table 4 - Culvert Standards by CBP Sector**

### 7.4.1 CULVERT GRATES

When culverts cross through the primary or secondary fence, and for pipes that are (b) (7)(E), secured grates or trash racks are required. For land border primary pedestrian fence, grates shall be placed on the U.S. side of the fence. For all other applications, the designer shall coordinate with CBP regarding the preferred location of required grates. Grates serve multiple purposes including security and maintenance. For security and safety reasons, the grates should be locked while in either closed or open positions. Grates will protect the culverts from blockage and damage from debris. Grates will require frequent inspection and maintenance for removal of debris that blocks flows and causes ponding at the upstream end of the culvert. For designed box culverts and culverts (b) (7)(E), the grate system must be designed such that there is no clear opening greater (b) (7)(E). The type of secured grate shall be similar to that shown in **Appendix D, Drainage Grate Standard Details**.

### 7.4.2 CULVERT CONSTRUCTION

The backfill adjacent to and above the culvert may be placed in conjunction with normal embankment construction. The bedding beneath the culvert should include pea gravel or a permeable material. Bedding shall be placed on compacted subgrade.



Erosion protection should be placed at both ends of every culvert. This may include either concrete or gabion basket headwalls or grouted rip-rap.

## 7.5 ROADSIDE DITCHES

A roadside ditch may be required to provide proper drainage along a border or access road. The size and capacity of the ditch will vary depending on the volume of water needing conveyance. If the full-flow capacity of the ditch yields a velocity greater than 3 feet per second, the ditch should be lined with erosion protection as described in **Section 7.6, Erosion Control**.

Prior to the design of the roadside ditch, access across the ditch shall be determined and confirmed with CBP to ensure that the presence of the ditch does not hinder Border Patrol's operational requirements. Where continuous or point specific access is required, the roadside ditch shall be of trapezoidal shape with a (b) (7)(E) minimum bottom width and a maximum side slope of 3.5 to 1 (horizontal to vertical) for concrete-lined, and 6 to 1 (horizontal to vertical) for earthen slopes. Where additional space within the roadway easement permits, shallower side slopes in particular for concrete lined ditches, shall be evaluated. Where access from the border or access road is not required across the roadside ditch, the ditch shall be designed solely based on drainage and geotechnical recommendations.

## 7.6 EROSION CONTROL

For any LWC or culvert(s) installations, erosion control is required at both upstream and downstream locations. Typically, erosion control is in the form of rip-rap. The minimum gradation size for rip-rap is D<sub>50</sub> of 6 inches, and the maximum size of rip-rap depends on the result of drainage analysis. All rip-rap with a D<sub>50</sub> of less than 18 inches shall be grouted. Other forms of erosion control, such as erosion control mats, concrete slope protection, and soil cement, shall be permitted as final design dictates and subject to CBP approval.

Newly constructed roadway embankments or exposed cuts will also require consideration for erosion control. Any slope 2 to 1 (horizontal to vertical) or steeper shall receive seeding when not on rock. Such slopes shall also be evaluated based on geotechnical recommendations for additional soil erosion prevention measures such as, but not limited to, concrete slope protection, geotextile, check dams, high performance turf reinforcing mat (see **Figure 28**), etc.



**Figure 28 - Erosion Control Using High Performance Turf Reinforcing Mat**

## SECTION 8. REFERENCES

(b) (7)(E)

Reference 12: Manual for Uniform Traffic Control Devices (MUTCD), <<http://mutcd.fhwa.dot.gov/>>

(b) (7)(E)

# **Chapter 2 – Fence Design Standards**

## SECTION 1. FENCE TYPES

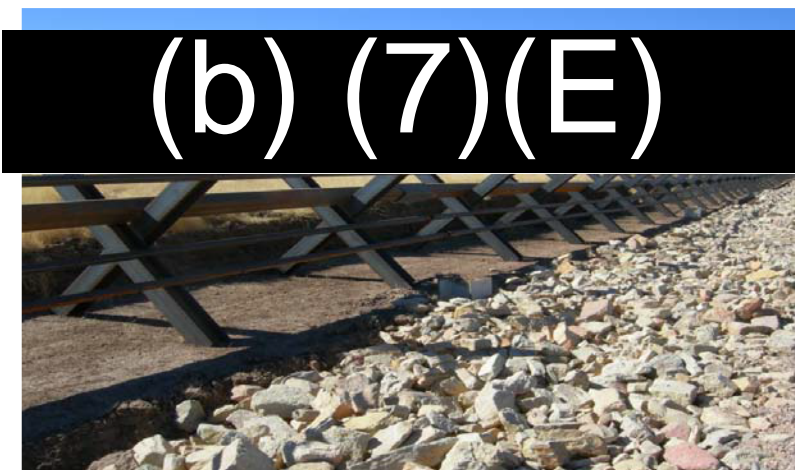
Up to three layers of fence are currently used by Border Patrol across the Southwest Border. The first layer of fence is considered the primary fence, and includes pedestrian fence (PF) and vehicle fence (VF).

- While Primary PF, **Figure 29, Primary Pedestrian Fence (Type P-3)**, is designed to (b) (7)(E). Included under these standards are five types of approved PF (P-1 through P-5) that are constructed using square steel tubes or solid steel square pickets as means for impedance. See **Appendix B, Fence & Gate Standard Details**, for PF details.



**Figure 29 – Primary Pedestrian Fence (Type P-3)**

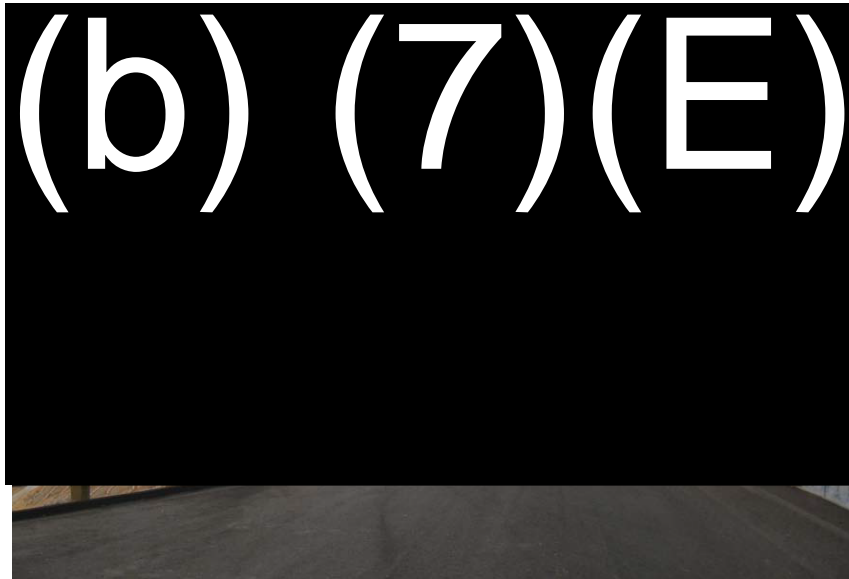
- The VF (b) (7)(E), **Figure 30, Vehicle Fence (Type V-2)**. Included under these standards are two types of approved VF (V-1 and V-2). The VF types are constructed using steel tubing and wide flange sections as the main fence components. See **Appendix B, Fence & Gate Standard Details**, for VF details.



**Figure 30 - Vehicle Fence (Type V-2)**

The next layer of fence used by CBP is called the secondary fence, **Figure 31, Secondary Fence (Type S-1)**. (b) (7)(E) Included under these

standards is one type of SF (S-1), with the option of either (b) (7)(E). See **Appendix B, Fence & Gate Standard Details**, for SF details.



**Figure 31 - Secondary Fence (Type S-1)**

The final layer of fence used by CBP is the tertiary fence. The tertiary fence is used as (b) (7)(E)

See **Appendix B, Fence & Gate Standard Details**, for tertiary fence details.

Following are descriptions of the various TI fence types and design criteria. For a list of standard specifications, see **Appendix A, Standard Specifications**. For standard fence details for the fence types, see **Appendix B, Fence & Gate Standard Details**.

## SECTION 2. PRIMARY PEDESTRIAN FENCE DESIGN STANDARDS

### 2.1 PRIMARY PEDESTRIAN FENCE TYPES

PF uses steel bollards or pickets to (b) (7)(E). The standard height for PF is (b) (7)(E) however, specific operational requirements can allow (b) (7)(E) (b) (7)(E) the fence types are detailed to allow for panelized installation methods. (b) (7)(E)

For a full description of the design criteria required for PF, see **Section 2.2, Primary Pedestrian Fence Design Criteria.**

#### 2.1.1 PICKET FENCE (TYPE P-1)

(b) (7)(E)

#### 2.1.2 BOLLARD FENCE (TYPE P-2)

(b) (7)(E)

#### 2.1.3 BOLLARD FENCE WITH STEEL PLATE (TYPE P-3)

(b) (7)(E)



(b) (7)(E)

#### 2.1.4 FLOATING BOLLARD FENCE (TYPE P-4)

(b) (7)(E)

#### 2.1.5 FLOATING PICKET FENCE (TYPE P-5)

(b) (7)(E)

## 2.2 PRIMARY PEDSTRIAN FENCE DESIGN CRITERIA

Design of the primary PF shall utilize standard details P-1 through P-5 and comply with the following design criteria, unless specifically directed or approved otherwise:

- Vehicular impact applied to the fence design (b) (7)(E)
- Vehicular impact loading shall be applied to the fence design and combined with all applicable load groups (b) (7)(E)
- The minimum compressive concrete strength for foundations shall be (b) (7)(E)

- (b) (7)(E)
- 
- 
- 
- 
- 

- Fence shall disallow ponding of water on either side of the border.
- Fence shall, where it is necessary, allow migration of all species and shall have minimal impact on habitat and animal dwelling patterns per environmental requirements. The need for and spacing of migratory features within a fence shall be determined on a project-by-project basis.

- (b) (7)(E)
- 
- 
- 

- Fence drainage impact shall be designed in accordance with criteria presented in **Section 6, Fence Drainage Protection Design Standards**.
- Provide construction workers and maintenance crew room to build/maintain fence without breaching border.
- The (b) (7)(E)

- All fence materials shall conform to the following:

- (b) (7)(E)
- 
- 
- 
- 
- 
- 
-

## SECTION 3. SECONDARY FENCE DESIGN STANDARDS

### 3.1 SECONDARY FENCE TYPES

Secondary Fence (SF) as a means of TI uses (b) (7)(E). The standard height for SF is (b) (7)(E). For a full description of the design criteria required for SF, see Section 3.2, Secondary Fence Design Criteria.

#### 3.1.1 MESH FENCE (TYPE S-1)

S-1 fence consists of (b) (7)(E).

### 3.2 SECONDARY FENCE DESIGN CRITERIA

Design of SF shall utilize standard details S-1 and comply with the following design criteria, unless specifically directed or approved otherwise:

- (b) (7)(E)
- 
- 
- 
- 
-

- (b) (7)(E)
- (b) (7)(E)
- Fence shall not allow ponding of water on either side of the fence.
- Fence shall, where it is necessary, to allow migration of all species and shall have minimal impact on habitat and animal dwelling patterns per environmental requirements. The need for and spacing of migratory features within a fence shall be determined on a project-by-project basis.
- The (b) (7)(E)
- (b) (7)(E)
- Fence design shall allow for expedient repair of damage or breaching to be completed within (b) (7)(E)
- All fence materials shall conform to the following:
  - (b) (7)(E)
  - (b) (7)(E)
  - (b) (7)(E)
  - (b) (7)(E)
  - (b) (7)(E)
  - (b) (7)(E)
  - (b) (7)(E)
  - (b) (7)(E)

## SECTION 4. TERTIARY FENCE DESIGN STANDARDS

### 4.1 TERTIARY FENCE TYPES

Tertiary Fence (TF) uses (b) (7)(E) (b) (7)(E) (b) (7)(E) For a full description of the design criteria required for TF, see **Section 4.2, Tertiary Fence Design Criteria.**

#### 4.1.1 CHAIN LINK FENCE (TYPE T-1)

T-1 fence consists of (b) (7)(E)

#### 4.1.2 BARBED WIRE FENCE (TYPE T-2)

T-2 fence consists of (b) (7)(E)

### 4.2 TERTIARY FENCE DESIGN CRITERIA

Design of the TF shall utilize standard details T-1 and T-2 and shall comply with the following design criteria, unless specifically directed or approved otherwise.

- (b) (7)(E)
- The minimum compressive concrete strength for foundations shall be (b) (7)(E)
- (b) (7)(E)
- Fence shall be site adaptable where necessary to allow migration of all species and have minimal impact on habitat and animal dwelling patterns per environmental requirements. The need for and spacing of migratory features within a fence shall be determined on a project-by-project basis.
- The (b) (7)(E)
- (b) (7)(E)
- All fence materials shall conform to the following:
  - (b) (7)(E)
  - (b) (7)(E)
  - (b) (7)(E)

## SECTION 5. PRIMARY VEHICLE FENCE DESIGN STANDARDS

### 5.1 PRIMARY VEHICLE FENCE TYPES

VF as a means of TI uses (b) (7)(E). For a full description of the design criteria required for VF, see Section 5.2, Primary Vehicle Fence Design Criteria.

#### 5.1.1 POST & RAIL FENCE (TYPE V-1)

V-1 fence consists of (b) (7)(E).

#### 5.1.2 NORMANDY FENCE (TYPE V-2)

V-2 fence is constructed of (b) (7)(E).

## 5.2 PRIMARY VEHICLE FENCE DESIGN CRITERIA

Design of primary VF shall utilize standard details V-1 and V-2 and shall comply with the following design criteria, unless specifically directed or approved otherwise.

- Vehicular impact applied to the fence design as (b) (7)(E)
  - (b) (7)(E)
- (b) (7)(E)
- Construction shall take place within temporary construction easement.
  - All fence materials shall conform to the following:
    - (b) (7)(E)



## SECTION 6. FENCE DRAINAGE PROTECTION DESIGN STANDARDS

Any alteration to existing conditions requires consideration of drainage effects as they relate to the installation or improvement of primary pedestrian, secondary, tertiary and primary vehicle fence (TI fence). TI fence shall be protected from erosion due to stormwater run-off and allow the conveyance of stormwater run-off design across the site. In addition, any TI fence constructed or improved within the Roosevelt Reservation, or 60 feet north of the land border, as well as any TI fence constructed within the Rio Grande and Colorado River floodplains, are required to comply with various border related treaties between the U.S. and Mexico. General drainage design criteria that shall be used for sizing erosion protection and conveyance measures as well as USIBWC treaty requirements is discussed in **Chapter 1, Roads & Signage Design Standards, Section 7.1, USIBWC Floodplain, and Section 7.2, General Drainage.**

### 6.1 DRAINAGE, SCOUR & EROSION CONTROL DESIGN

To meet the USIBWC requirements for impacts to WSE within drainage crossings, three means of increasing drainage conveyance through the primary pedestrian fence types P-1, P-2 and P-3 have been accepted by CBP and USIBWC. The first means of increasing drainage conveyance (applicable only to primary pedestrian fence types P-2 and P-3) is to (b) (7)(E)

See drawings for primary pedestrian fence Types P-2 and P-3 Section B located in **Appendix B, Fence & Gate Standard Details**, for additional clarification. (b) (7)(E)

See **Chapter 3, Gate Design Standards**, for additional drainage gate requirements. Where primary pedestrian fence types P-4 and P-5 are the specified fence type to be installed, the primary fence will be required to transition to Type P-1, P-2 or P-3 at all drainage crossings.

While drainage crossings at secondary, tertiary and primary vehicle fence types can have significantly less impact at the border compared to primary pedestrian fence types, the designer shall still comply with USIBWC treaty requirements. Whereas upon completion of the analysis, the results show that the fence in question, impacts the water surface elevation above acceptable limits, the designer shall implement means of drainage conveyance (b) (7)(E)

In addition to meeting USIBWC requirements, the fence shall also be protected from scour and erosion. (b) (7)(E)

Once fence scour requirements are met, erosion control shall be evaluated at both upstream and downstream locations of the fence.

Typically, erosion control is in the form of LWC and/or grouted rip-rap. The minimum gradation size for rip-rap is D<sub>50</sub> of 6 inches, and the maximum size of rip-rap depends on the result of drainage analysis. All rip-rap with a D<sub>50</sub> of less than 18 inches shall be grouted. Other forms of erosion control, such as erosion control mats, concrete slope protection, or soil cement shall be permitted as final design dictates and subject to CBP approval.

## SECTION 7. REFERENCES

Reference 15: (b) (7)(E)

# **Chapter 3 – Gate Design Standards**

**SECTION 1. GATES TYPES**

When vehicle, personnel or drainage gates (See **Figure 32**) are required to be integrated into any type of TI fence, design criteria, requirements and construction materials established for the surrounding TI fence shall be seamless through the gate structure. CBP utilizes both manual and automated/mechanized gates with their TI fence systems as conditions dictate.



**Figure 32 - Drainage Gates in Type 3 Primary PF**

## SECTION 2. MANUALLY OPERATED GATE DESIGN STANDARDS

Gates shall be secured to the TI fence type by (b) (7)(E) /16 (b) (7)(E), unless specifically noted or detailed otherwise. Manually operated gates shall be locked into place using (b) (7)(E). Gates shall typically be supported using (b) (7)(E). See Appendix B, **Fence & Gate Standard Details**, for standard gate details for the various gate types. See Appendix A, **Standard Specifications** for standard specifications.

### 2.1 MANUALLY OPERATED GATE TYPES

#### 2.1.1 PRIMARY PEDESTRIAN FENCE VEHICLE GATE (TYPE G-1)

G-1 Vehicle Gate is used with primary pedestrian fence and consists of (b) (7)(E)



#### 2.1.2 PRIMARY PEDSTRIAN FENCE PERSONNEL BOLLARD GATE (TYPE G-2)

G-2 Pedestrian Gate is used with primary pedestrian bollard fence and consists of (b) (7)(E)



(b) (7)(E)

### 2.1.3 PRIMARY PEDESTRIAN FENCE PERSONNEL PICKET GATE (TYPE G-3)

G-3 Personnel Gate is used with primary pedestrian picket fence and consists of (b) (7)(E)

### 2.1.4 SECONDARY FENCE VEHICLE GATE (TYPE G-4)

G-4 Vehicle Gate is used with SF and consists of (b) (7)(E)

### 2.1.5 SECONDARY FENCE PERSONNEL GATE (TYPE G-5)

G-5 Personnel Gate is used with SF and consists of (b) (7)(E)



### 2.1.6 TERTIARY FENCE GATE (TYPE G-6)

G-6 Gate is used with TF and consists of (b) (7)(E)

[REDACTED]

### 2.1.7 SLIDING VEHICLE GATE (TYPE SG-1)

A sliding vehicle gate can be used in PF or SF and consists of (b) (7)(E)

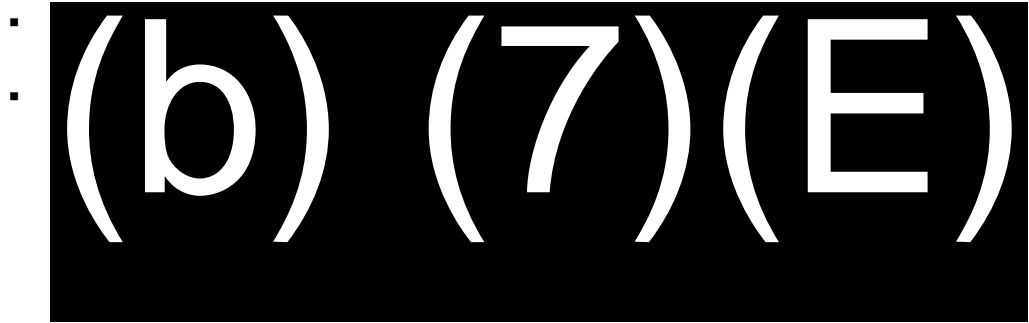
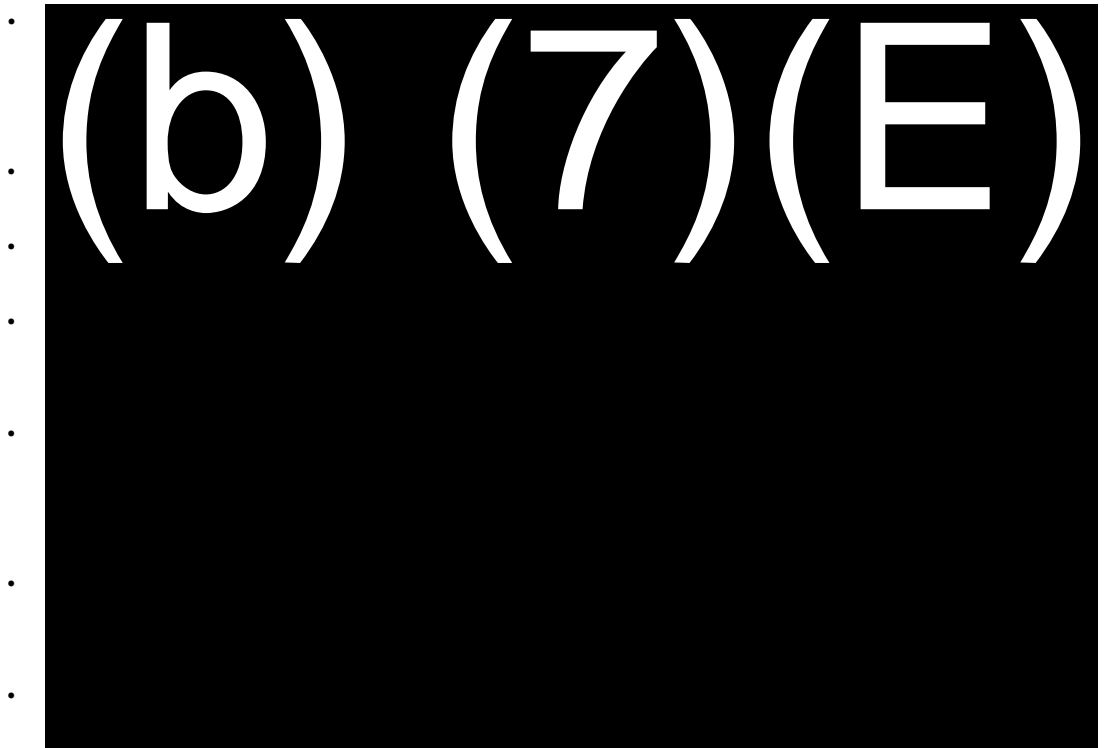
[REDACTED]

## 2.2 MANUALLY OPERATED GATE DESIGN CRITERIA

Gates shall adhere to all design criteria as established under the fence type the gate is to be integrated into. In addition, gates shall conform to the following:

### 2.2.1 GENERAL DESIGN CRITERIA

- Design of manually operated gates shall utilize Swing Gate Standard Details (Types G-1 through G-5) and Sliding Vehicle Gate Standard Detail (Type SG-1), located in **Appendix B, Fence & Gate Standard Details**.
- Gate framing shall be designed to (b) (7)(E)
- Vehicular gates that require larger than (b) (7)(E) wide clear openings shall require special design analysis and direction on a project-by-project basis.

**2.2.2****SWING GATE DESIGN CRITERIA****2.2.3****SLIDE GATE DESIGN CRITERIA (b) (7)(E) CLEAR OPENING OR LESS)**

**2.2.4****SLIDE GATE DESIGN CRITERIA (MORE THAN (b) (7)(E) CLEAR OPENING)**

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(b) (7)(E)

### SECTION 3. AUTOMATED/MOTORIZED PRIMARY PEDESTRIAN FENCE VEHICLE GATES DESIGN STANDARDS

PF vehicle gates that require (b) (7)(E) shall conform to all design criteria as established under separate CBP developed design. (b) (7)(E) installed (b) (7)(E) (b) (7)(E) Each gate has (b) (7)(E) provided on (b) (7)(E)

(b) (7)(E) For a full description of the requirements and specifications, see **Appendix G, Automated/Motorized Primary Pedestrian Fence Vehicle Gate.**

## SECTION 4. DRAINAGE GATE DESIGN STANDARDS

Drainage Gate (Type DG-1) consists of swing gates mounted on a fixed post. The drainage gate structure consists of (b) (7)(E)

. For ease of construction and aesthetic appeal, (b) (7)(E)

The design engineer shall specify the number of drainage swing gates required for a given location. Each gate shall have a minimum of (b) (7)(E)

### 4.1 DRAINAGE GATE DESIGN CRITERIA

Gates shall adhere to all design criteria as established under the respective fence type into which the gate is being inserted. In addition, gates shall conform to the following:

- 
- 
- 

(b) (7)(E)

## SECTION 5. GATE DRAINAGE PROTECTION DESIGN STANDARDS

Any alteration to existing conditions requires consideration of drainage effects as they relate to the installation or improvement of primary pedestrian, secondary, tertiary fence gates (TI gates). TI gates shall be protected from erosion due to stormwater run-off and allow the conveyance of stormwater run-off design across the site. In addition, any TI gates constructed or improved within the Roosevelt Reservation, or 60 feet north of the land border, as well as any TI fence constructed within the Rio Grande and Colorado River floodplains, are required to comply with various border related treaties between the U.S. and Mexico. For general drainage design criteria that shall be used for sizing erosion protection and conveyance measures as well as USIBWC treaty requirements are discussed in **Chapter 1, Road, Bridge & Signage Design Standards, Section 7.1, USIBWC Floodplain and Section 7.2, General Drainage.**

# **Chapter 4 – Lighting Design Standards**



## SECTION 1.GENERAL

### 1.1 CODE COMPLIANCE

Lighting for all border-related TI projects shall conform to the (b) (7)(E) (Reference 16, page 67) Guidelines and local electric codes, whichever is more stringent. Construction specifications shall conform to those provided in **Appendix A, Standard Specifications**. All projects shall comply with the latest locally adopted version of the (b) (7)(E) (Reference 17, page 67). **Figure 33, TI Lighting**, shows a typical lighting installation located adjacent to the Roosevelt Reservation line.

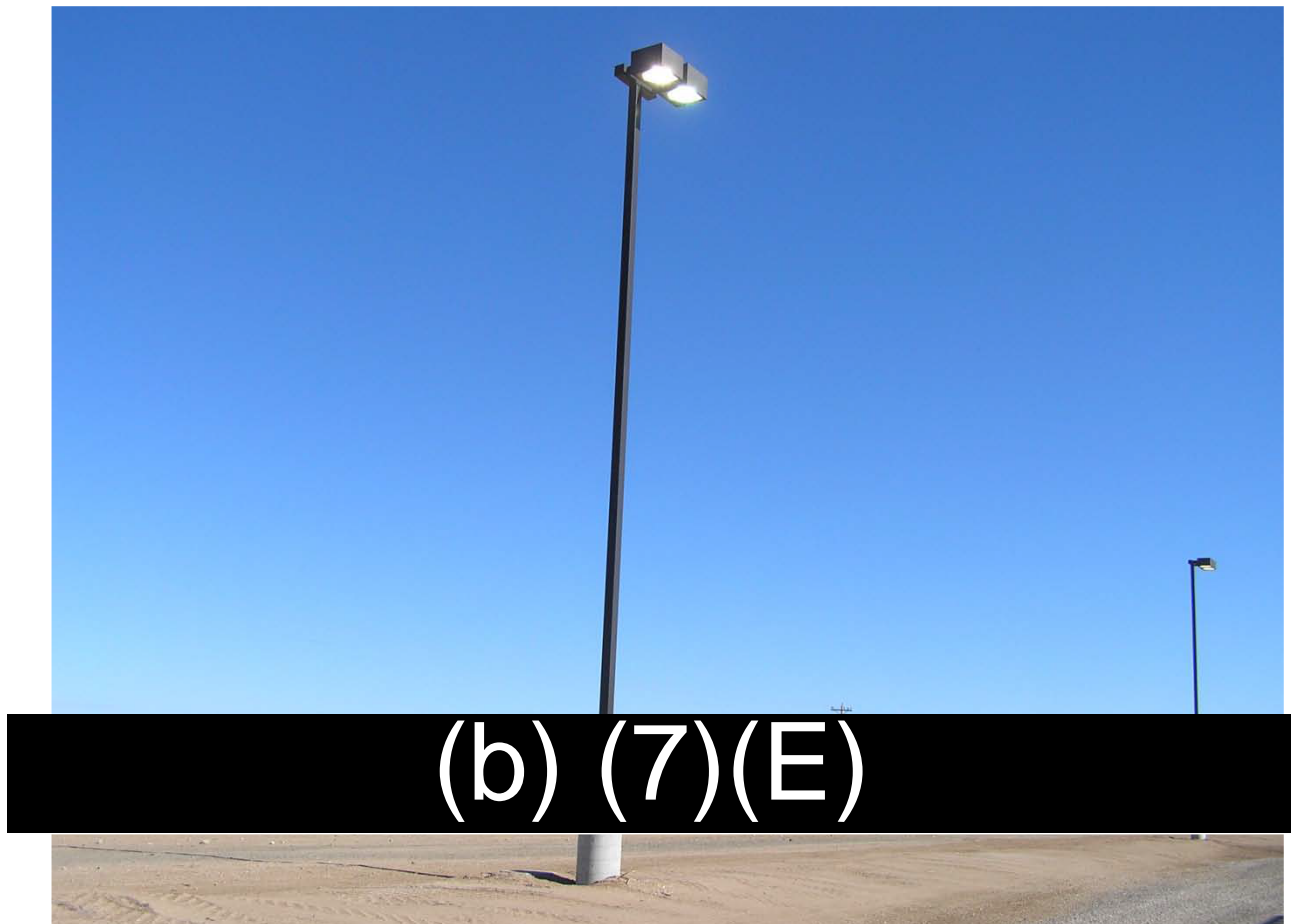


Figure 33 - TI Lighting

## SECTION 2. LIGHTING DESIGN STANDARDS

### 2.1 LIGHTING LEVELS

Lighting along the international border shall be placed (b) (7)(E) as designated by CBP and shall provide (b) (7)(E) or PF, if present. CBP environmental subject matter experts shall be consulted with on a project-by-project basis to confirm the average foot candle illumination requirements and whether lighting shields shall be attached to the luminaires to control light spillage north of the lights. See **Appendix C, Lighting Standard Details**, for photometric details.

### 2.2 POLE MOUNTED LIGHTS

All light poles shall be (b) (7)(E) specification located in **Appendix A, Standard Specifications**. (b) (7)(E) See **Appendix C, Lighting Standard Details**, for associated pole mounted light details.

### 2.3 GATE MOUNTED LIGHTS

Where flood lights are required at (b) (7)(E), the light system shall be (b) (7)(E). CBP environmental subject matter experts shall be consulted with on a project-by-project basis to confirm the average foot candle illumination requirements and whether lighting shields shall be attached to the luminaires to control light spillage north of the lights. (b) (7)(E), see

**Appendix C, Lighting Standard Details.**

(b) (7)(E)

[REDACTED]

## SECTION 3. POWER DISTRIBUTION DESIGN STANDARDS

### 3.1 SERVICE ENTRANCE

Coordination with the local utility company shall occur to bring primary power to the site. Coordination regarding service entrance section (SES) location must occur. SESs typically will consist of (b) (7)(E). Amperages for SESs will vary depending on project size. SESs will consist of all necessary over current protection devices (circuit breakers), metering section, panel boards, step down transformers (for 120-volt circuitry), and the lighting control panel. SESs shall be installed (b) (7)(E). (b) (7)(E) see drawings in **Appendix C, Lighting Standard Details**.

### 3.2 CONDUCTORS AND CONDUIT

Conductors and conduit shall be (b) (7)(E). (b) (7)(E). Selected backfill shall be used for (b) (7)(E). Conductors and conduit shall be sized accordingly to compensate for any voltage drop.

### 3.3 JUNCTION BOXES

Junction boxes shall be (b) (7)(E) in order to aid the contractor in avoiding longer conductor pulls. (b) (7)(E). Junction box sizes are to be field-determined utilizing the sizing chart shown on the plans. Place junction boxes to facilitate drainage away from the boxes.

## SECTION 4. LIGHTING DRAINAGE PROTECTION DESIGN STANDARDS

Any alteration to existing conditions requires consideration of drainage effects as they relate to the installation or improvement of TI gates. TI gates shall be protected from erosion due to stormwater run-off and allow the conveyance of stormwater run-off design across the site. In addition, any TI gates constructed or improved within the Roosevelt Reservation, or 60 feet north of the land border, as well as any TI fence constructed within the Rio Grande and Colorado River floodplains, are required to comply with various border related treaties between the U.S. and Mexico. For general drainage design criteria that shall be used for sizing erosion protection and conveyance measures as well as USIBWC treaty requirements are discussed in **Chapter 1, Road & Signage Design Standards, Section 7.1, USIBWC Floodplain** and **Section 7.2, General Drainage**.

### 4.1 EROSION CONTROL

Where TI lighting is required to be located with drainage crossings, erosion control is required at the light pole, conduit, and equipment locations. Typically, erosion control is in the form of rip-rap. The minimum gradation size for rip-rap is D<sub>50</sub> of 6 inches. Drainage analysis for lighting erosion control shall be performed using the 25-year storm event. All rip-rap with a D<sub>50</sub> of less than 18 inches shall be grouted. Other forms of erosion control, such as erosion control mats, concrete slope protection, or soil cement shall be permitted as final design dictates and subject to CBP approval.

## SECTION 5. REFERENCES

Reference 16:

(b) (7)(E)

Reference 17:

## APPENDIX A STANDARD SPECIFICATIONS

SECTION 03 20 01.00 10

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

(b) (7)(E)

AMERICAN WELDING SOCIETY (AWS)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

(b) (7)(E)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:



## SD-02 Shop Drawings

### Reinforcement; G

Detail drawings showing reinforcing steel placement, schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

## SD-03 Product Data

### Welding

A list of qualified welders names.

## SD-07 Certificates

### Reinforcing Steel

Certified copies of mill reports attesting that the reinforcing steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified herein, prior to the installation of reinforcing steel.

## 1.3 QUALITY ASSURANCE

Welders shall be qualified in accordance with AWS D1.4/D1.4M. Qualification test shall be performed at the worksite and the Contractor shall notify the Contracting Officer 24 hours prior to conducting tests. Special welding procedures and welders qualified by others may be accepted as permitted by AWS D1.4/D1.4M.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

## PART 2 PRODUCTS

### 2.1 DOWELS

Dowels shall conform to (b) (7)(E). Steel pipe conforming to (b) (7)(E)

### 2.2 FABRICATED BAR MATS

Fabricated bar mats shall conform to (b) (7)(E)

### 2.3 REINFORCING STEEL

Reinforcing steel shall be deformed bars conforming to (b) (7)(E), grades and sizes as indicated.

### 2.4 WELDED WIRE FABRIC

Welded wire fabric shall conform to (b) (7)(E)

## 2.5 WIRE TIES

Wire ties shall be (b) (7)(E).

## 2.6 SUPPORTS

Bar supports for formed surfaces shall be designed and fabricated in accordance with (b) (7)(E)

# PART 3 EXECUTION

## 3.1 REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of (b) (7)(E)

### 3.1.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete in accordance with (b) (7)(E)

### 3.1.2 Splicing

Splices of reinforcement shall conform to (b) (7)(E)

(b) (7)(E). Welding shall conform to AWS (b) (7)(E). Welded butt splices shall be full penetration butt welds. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than (b) (7)(E)

Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop (b) (7)(E) of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

## 3.2 WELDED-WIRE FABRIC PLACEMENT

Welded-wire fabric shall be placed (b) (7)(E)

### 3.3 DOWEL INSTALLATION

Dowels shall be installed in (b) (7)(E)

-- End of Section --

SECTION 03 30 00.00 40  
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

(b) (7)(E)

AMERICAN WELDING SOCIETY (AWS)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

(b) (7)(E)



(b) (7)(E)



CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

(b) (7)(E)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

(b) (7)(E)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

(b) (7)(E)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-01 Preconstruction Submittals

Construction Equipment Lists shall be submitted by the Contractor prior to construction in accordance with the paragraph entitled, "General Information," of this section.

### SD-03 Product Data

Manufacturer's catalog data for the following items shall include printed instructions for admixtures, bonding agents, epoxy-resin adhesive binders, waterstops, and liquid chemical floor hardeners.

- Concrete Aggregates
- Portland Cement
- Ready-Mix Concrete
- Form Facing Materials
- Reinforcement Materials
- Joint Materials
- Bonding Materials
- Concrete Curing Materials

### SD-05 Design Data

Mix design data for each class of Ready-Mix Concrete shall be submitted at least 15 calendar days prior to start of specified work; G

### SD-06 Test Reports

Test reports for welding electrodes shall be in accordance with (b) (7)(E).

Reports for concrete shall be in accordance with the paragraph entitled, "Quality-Control Testing During Construction," of this section. Test reports of the chemical requirements of reinforcing bars shall also be submitted.

- Chemical Composition
- Mechanical Usability
- Soundness

Slump  
Air Entrainment  
Compressive Strength

#### SD-07 Certificates

Welding Procedures shall be in accordance with (b) (7)(E) .

Mill certificates shall be submitted for Steel Bar according to the paragraph entitled, "Fabrication," of this section.

Certificates for concrete shall be in accordance with the paragraph entitled, "Classification and Quality of Concrete," of this section. Certificates shall contain project name and number, date, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer, brand name of manufactured materials, material name, values as specified for each material, and test results. Certificates for Welder Qualifications shall be in accordance with the paragraph entitled, "Qualifications for Welding Work," of this section.

Concrete Design Mixes  
Concrete Aggregates  
Welding Procedures

#### SD-08 Manufacturer's Instructions

Installation instructions shall indicate the manufacturer's recommended method and sequence of installation for the following items:

Admixtures  
Bonding Materials

#### SD-11 Closeout Submittals

Records of Communication shall be submitted in accordance with paragraph entitled, "General Information," of this section.

### 1.3 QUALIFICATIONS FOR CONCRETE TESTING SERVICE

Concrete testing shall be performed by a Government approved commercial testing laboratory and inspection service experienced in sampling and testing concrete. Testing agency shall meet the requirements of (b) (7)(E) .

### 1.4 QUALIFICATIONS FOR WELDING WORK

Welding procedures shall be in accordance with (b) (7)(E) .

Welder qualifications shall be verified in accordance with (b) (7)(E) or under an equivalent qualification test approved in advance. Welders shall be permitted to do only the type of welding for which each is specifically qualified.

### 1.5 CONCRETE SAMPLING AND TESTING



Testing by the Contractor shall include sampling and testing concrete materials proposed for use in the work and testing the design mix for each class of concrete. Quality control testing during construction shall be performed by the Contractor.

Concrete aggregate materials proposed for use in the work shall be sampled and tested in accordance with (b) (7)(E)

Portland cement shall be sampled and tested in accordance with (b) (7)(E)

Air-entraining admixtures shall be sampled and tested in accordance with (b) (7)(E).

#### 1.6 CONCRETE DESIGN MIXES

Mix proportions for each concrete class shall be determined and tested as follows:

<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
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(b) (7)(E)		
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(b) (7)(E)

Proportions of concrete mixtures shall be determined in accordance with (b) (7)(E)

#### 1.7 DELIVERY AND STORAGE OF MATERIALS

Packaged materials shall be delivered to the project site in their original, unopened package or container bearing label clearly identifying manufacturer's name, brand name, material, weight or volume, and other pertinent information. Packaged materials shall be stored in their original, unbroken package or container in a weathertight and dry place until ready for use in the work.

Unpackaged aggregates shall be stored to avoid excessive segregation, contamination with other materials or other size aggregates, or freezing.

Reinforcement and other metal items shall be protected from corrosion and shall be kept free from ice, grease, and other coatings that would destroy or reduce bond.

#### 1.8 GENERAL INFORMATION

Construction Equipment Lists of major components used during this phase of work shall be submitted prior to construction.

Letters of record expressing Communication between the Contractor and Contracting Officer shall be provided after the contract completion.

### PART 2 PRODUCTS

#### 2.1 CONCRETE MATERIALS

##### 2.1.1 General

All concrete materials for cast-in-place concrete, except for concrete bulkheads, shall conform (b) (7)(E)

except as modified herein.

2.1.2 (b) (7)(E)

All concrete materials for cast-in-place concrete (b) (7)(E) shall conform (b) (7)(E) except as modified herein.

2.1.3 Portland Cement

Cement shall conform (b) (7)(E) or approved equal. One brand and type of cement shall be used for formed concrete having exposed-to-view finished surfaces.

2.1.4 Water

Minimize the amount of water in the mix. The amount of water must not exceed (b) (7)(E) by weight of cementitious materials (cement + pozzolans), and in general, improve workability by adjusting the grading rather than by adding water. Water must be fresh, clean, and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

2.2 FORM FACING MATERIALS

2.2.1 Concrete Form Plywood (Standard Rough)

Plywood shall conform to NIST PS 1, B-B, concrete form, not less than 5/8-inch thick.

2.2.2 Overlaid Concrete Form Plywood (Standard Smooth)

Plywood shall conform to NIST PS 1, B-B, high density form overlay, not less than 5/8-inch thick.

2.3 REINFORCEMENT MATERIALS

See Section 03 20 01.00 10 Concrete Reinforcing for requirements.

2.4 JOINT MATERIALS

2.4.1 Preformed Joint Filler Strips

Filler strips shall be nonextruding and resilient nonbituminous type conforming to (b) (7)(E).

2.4.2 Joint Sealant Compound

Compound shall be (b) (7)(E).

2.5 BONDING MATERIALS

2.5.1 Concrete Bonding Agent

(b) (7)(E)

2.5.2 Epoxy-Resin Adhesive Binder

## 2.6 CONCRETE CURING MATERIALS

### 2.6.1 Absorptive Cover

Cover for curing concrete shall be burlap cloth made from jute or kenaf, weighing 9 ounces plus or minus 5 percent per square yard when clean and dry, conforming to ASTM C 171, Class 3; or cover may be cotton mats as approved.

### 2.6.2 Moisture-Retaining Cover

Cover for curing concrete shall be waterproof paper conforming to ASTM C 171, regular or white, or polyethylene sheeting conforming to ASTM C 171, or polyethylene-coated burlap consisting of a laminate of burlap and a white opaque polyethylene film permanently bonded to the burlap; burlap shall conform to ASTM C 171, Class 3, and polyethylene film shall conform to ASTM C 171. When tested for water retention in accordance with ASTM C 156, weight of water lost 72 hours after application of moisture retaining covering material shall not exceed 0.039 gram per square centimeter of the mortar specimen surface.

### 2.6.3 Water

Water shall be potable.

### 2.6.4 Membrane-Forming Curing Compound

Compound shall be liquid type conforming to ASTM C 309, Type 1, clear, Type 1D with fugitive dye for interior work and Type 2, white, pigmented for exterior work.

## PART 3 EXECUTION

### 3.1 FORMWORK

#### 3.1.1 General

Forms shall be constructed to conform, within the tolerances specified, to shapes dimensions, lines, elevations, and positions of cast-in-place concrete members as indicated. Forms shall be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

#### 3.1.2 Design and Construction of Form work

Form work design and construction shall conform to ACI/MCP-2 and ACI 301, Chapter 4.

Forms shall be tight to prevent leakage of cement paste during concrete placing.

Form facing materials shall be supported by structural members spaced close to prevent deflection of form facing material. Forms placed in successive units for continuous surfaces shall be fitted to accurate alignment to ensure a smooth completed surface within the tolerances specified. Where necessary to maintain the tolerances specified, such as long spans where immediate supports are not possible, formwork shall be cambered for anticipated deflections in formwork due to weight and pressure of fresh concrete and to construction loads.

Exposed joints, edges, and external corners shall be chamfered a minimum of (b) (7)(E) by moldings placed in corners of column, beam, and wall forms.

Shores and struts shall be provided with a positive means of adjustment capable of taking up formwork settlement during concrete placing operations. Adjustment shall be obtained with wedges or jacks or a combination thereof. When adequate foundations for shores and struts cannot be secured, trussed supports shall be provided.

Temporary openings shall be provided in wall forms, column forms, and at other points where necessary to permit inspection and to facilitate cleaning.

Forms shall be readily removable without impact, shock, or damage to concrete.

### 3.1.3 Forms for Standard Rough Form Finish

Rough form finish shall be given concrete formed surfaces that are to be concealed by other construction, unless otherwise specified.

Form facing material for standard rough form finish shall be the specified concrete form plywood or other approved form facing material that will produce concrete surfaces equivalent in smoothness and appearance to that produced by new concrete form plywood panels.

For concrete surfaces exposed only to the ground, undressed, square-edge, 1-inch nominal thickness lumber may be used. Horizontal joints shall be level and vertical joints shall be plumb.

### 3.1.4 Forms for Standard Smooth Form Finish

Smooth form finish shall be given concrete formed surfaces that are to be exposed to view or that are to be covered with coating material applied directly to concrete or with covering material bonded to concrete, such as waterproofing, dampproofing, painting, or other similar coating system.

Form facing material for standard smooth finish shall be the specified overlaid concrete form plywood or other approved form facing material that is nonreactive with concrete and that will produce concrete surfaces equivalent in smoothness and appearance to that produced by new overlaid concrete form plywood panels.

Maximum deflection of form facing material between supports and maximum deflection of form supports such as studs and wales shall not exceed 0.0025 times the span.

Arrangement of form facing sheets shall be orderly and symmetrical, and sheets shall be in sizes as large as practical.

Panels shall be arranged to make a symmetrical pattern of joints. Horizontal and vertical joints shall be solidly backed and butted tight to prevent leakage and fins.

### 3.1.5 Form Ties

Ties shall be factory fabricated metal, adjustable in length, removable or snap-off type that will not allow form deflection or will not spall concrete upon removal. Portion of form ties remaining within concrete after removal of exterior parts shall be at least (b) (7)(E) back from concrete surface. Form ties shall be free of devices that will leave a hole larger than (b) (7)(E) in diameter in concrete surface. Form ties fabricated at the project site or wire ties of any type are not acceptable.

### 3.1.6 Tolerances for Form Construction

Formwork shall be constructed to ensure that after removal of forms and prior to patching and finishing of formed surfaces, concrete surfaces shall be in accordance with tolerances specified in (b) (7)(E)

### 3.1.7 Preparation of Form Surfaces

Contact surfaces of forms shall be coated with form-coating compound before reinforcement is placed. Form-coating compound shall be a commercial formulation that will not bond with, stain, nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces that entails bonding or adhesion nor impede wetting of surfaces to be cured with water or curing compounds. Excess form-coating compound shall not be allowed to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete will be placed. Thinning of form-coating compound shall be made with thinning agent of the type, in the amount, and under the conditions recommended by form-coating compound manufacturer's printed or written directions.

### 3.1.8 Removal of Forms

Formwork that does not support weight of concrete, such as sides of beams, walls, columns, and similar vertical parts of the work, may be removed 24 hours after placing concrete, provided concrete is sufficiently hard not to be damaged from form-removal operations.

Formwork that supports weight of concrete, such as beam soffits, slabs, and similar horizontal parts of the work, shall remain in place at least until concrete has attained design minimum laboratory compressive strength at 28 days for applicable concrete class specified.

Form facing material may be removed before concrete has attained its required 28-day compressive strength but in no case less than 6 days after placing concrete, provided shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports. Shores and other vertical supports shall remain in place until concrete has attained its required 28-day compressive strength.

Results of control tests will be used as evidence that concrete has attained sufficient strength to permit removal of supporting forms. Test specimens shall be removed from molds at the end of 24 hours and stored in the structure as near points of sampling as possible; shall receive same protection from elements during curing as is given those portions of the structure which they represent; and shall not be removed from the structure for transmittal to the laboratory prior to expiration of three-fourths of proposed period before removal of forms. Supporting forms of shoring shall not be removed until strength of control-test specimens has attained a value of at least (b) (7)(E) for other work. Contractor shall ensure that newly unsupported portions of the structure are not subjected to heavy construction or material loading.

Tie-rod clamps to be removed from wall shall be loosened 24 hours after concrete is placed; form ties, except for a sufficient number to hold forms in place, may be removed at that time. Ties wholly withdrawn from wall shall be pulled toward inside face.

When formwork is removed during concrete curing period, exposed concrete shall be cured as specified.

### 3.1.9 Re-Use of Forms

Surfaces of forms that are to be re-used shall be cleaned and repaired, except that split, frayed, or delaminated form facing material shall not be re-used. Contact surfaces of re-used forms shall be coated as specified.

### 3.2 REINFORCEMENT FABRICATION AND INSTALLATION

See Section 03 20 01.00 10 Concrete Reinforcing for requirements.

### 3.3 JOINTS

#### 3.3.1 Construction Joints

Joints not indicated shall be made and located so as not to impair strength and appearance of the structure and shall be as approved. Construction joints shall be located as follows:

(b) (7)(E)

(b) (7)(E)

(b) (7)(E)

Joints shall be perpendicular to main reinforcement. Reinforcement shall be continued across construction joints.

#### 3.3.2 Control Joints in Slabs on Ground

Joints shall be provided to form panels as indicated.

(b) (7)(E)

Joints shall be (b) (7)(E) and shall be formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface or by cutting the concrete with a saw after the concrete has set. After concrete has cured for at least 7 days, the Contractor shall remove inserts and clean groove of foreign matter and loose particles.

#### 3.3.3 Sealing Joints in Slabs on Ground

Isolation and control joints which will not be covered with finish flooring material shall be sealed with joint sealing compound after concrete curing period. Groove shall be slightly underfilled with joint sealing compound to prevent extrusion of compound. Excess material shall be removed as soon after sealing as possible.

Sealing shall not be required for isolation and control joints which will be covered with finish flooring material. Groove shall be left ready to receive filling material that will be provided as part of finish floor covering work.

### 3.4 INSTALLATION OF ANCHORAGE DEVICES

#### 3.4.1 General

Anchorage devices and embedded items required for other work that is attached to, or supported by, cast-in-place concrete shall be set and built in as part of the work of this section, using setting drawings, instructions, and directions for work to be attached thereto.

#### 3.4.2 Placing Anchorage Devices

Anchorage devices and embedded items shall be positioned accurately and supported against displacement. Openings in anchorage devices such as slots and threaded holes shall be filled with an approved, removable material to prevent entry of concrete into openings.

#### 3.5 PLACEMENT OF CONCRETE FOR (b) (7)(E)

(b) (7)(E)

#### 3.6 PREPARATIONS FOR CONCRETE PLACING

##### 3.6.1 General

Surfaces against which concrete is to be placed shall be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing. Standing water shall be removed prior to placement of concrete. Sub-grade surface shall be sprinkled with water as required to eliminate suction at the time concrete is deposited.

##### 3.6.2 Sub-grade Under Foundations, Footings and Slabs

See Earthwork Section 31 00 00 for sub-grade preparation requirements.

##### 3.6.3 Formwork

Formwork where used shall be complete and approved. Debris and foreign material shall be removed from interior of forms before start of concrete placing.

##### 3.6.4 Edge Forms and Screed Strips for Slabs/Pads

Edge forms or bulkheads and intermediate screed strips for slabs/pads shall be set to obtain indicated elevations and contours in finished slab/pad surface and shall be strong to support vibrating bridge screeds or roller pipe screeds if nature of specified slab/pad finish requires use of such equipment. Concrete surface shall be aligned to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

##### 3.6.5 Reinforcement and Other Embedded Items

Reinforcement, joint materials, and other embedded materials shall be secured in position, inspected, and approved before start of concrete placing.

#### 3.7 CONCRETE CONVEYING



### 3.7.1 Transfer of Concrete At Project Site

Concrete shall be handled from point of delivery and transfer to concrete conveying equipment and to locations of final deposit as rapidly as practical by methods which will prevent segregation and loss of concrete mix materials.

### 3.7.2 Mechanical Equipment for Conveying Concrete

Equipment shall ensure a continuous flow of concrete at delivery end and shall be as approved. Runways for wheeled concrete-conveying equipment shall be provided from concrete delivery point to locations of final deposit. Interior surfaces of concrete conveying equipment shall be free of hardened concrete, debris, water, snow, ice, and other deleterious substances.

## 3.8 CONCRETE PLACING

### 3.8.1 Weather Limitations and Protection

Concrete shall not be placed when the temperature of the concrete exceeds 90 degrees F, nor when the ambient temperature is below 40 degrees F, nor during rain, sleet, or snow, unless protection is provided, nor after 90-minutes from the time shown on the batch ticket to the time of placement.

When concrete is placed at 90 degree F or better it shall be covered and kept continuously wet for a minimum of 48 hours. Protection shall be provided during cold weather in accordance with (b) (7)(E).

During inclement weather, protection material shall be watertight to prevent entry of rain, sleet, or snow onto surfaces to receive concrete and into fresh concrete.

Protection materials shall be stored at project site for use in event of unforeseen weather changes after start of concrete placing operations.

### 3.8.2 General Placing Requirements

Concrete shall be deposited continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be provided as specified. Concrete placing shall be performed at such a rate that concrete which is being integrated with fresh concrete is still plastic. Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Concrete shall not be subjected to procedures which will cause segregation.

Concrete which becomes non-plastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials shall not be used. Use of retempered concrete will not be permitted. Rejected concrete shall be removed from the site.

### 3.8.3 Placing Concrete in Forms

Temporary spreaders in forms shall be removed when concrete placing has reached elevation of spreaders.

Concrete placed in forms shall be consolidated by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Vibrators shall be designed to operate with vibratory element submerged in concrete and shall maintain a speed of not less than 9,000 impulses per minute when

submerged in concrete. Vibrating equipment shall be adequate in number of units and power of each unit to properly consolidate concrete. Vibration of forms and reinforcement shall not be permitted. Vibrators shall not be used to transport concrete inside forms. Vibrators shall be inserted and withdrawn vertically at uniformly spaced points not farther apart than visible effectiveness of machine. Vibrator shall not be inserted into lower courses of concrete that have begun to set. At each insertion, duration of vibration shall be limited to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of concrete mix.

Placing of concrete in supporting elements shall not be started until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 hours.

#### 3.8.4 Placing Concrete on Grade

Concrete for foundations and slabs shall be placed and consolidated in a continuous operation, within the limits of approved construction joints if any until placing of panel or section is completed.

During concrete placing operations, concrete shall be consolidated by mechanical vibrating equipment so that concrete is worked around reinforcement and other embedded items. Concrete placed in supported slabs or pads shall be consolidated by mechanical vibrators as directed. Otherwise concrete in slabs/pads shall be consolidated by vibrating bridge screeds, roller pipe screeds, or other approved method. Consolidation operations shall be limited to time necessary to obtain consolidation of concrete without bringing an excess of fine aggregate to the surface. Concrete to be consolidated shall be as dry as practical and surfaces thereof shall not be manipulated prior to finishing operations. Concrete shall be brought to correct level with a straightedge and struck-off. Bull floats or darbies shall be used to smooth surface, leaving it free of humps or hollows. Sprinkling of water on plastic surface shall not be permitted.

#### 3.8.5 Bonding

Surfaces of set concrete at joints, except where bonding is obtained by use of concrete bonding agent, shall be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Surfaces shall be roughened in a manner that will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Bonding of fresh concrete that has set shall be obtained as follows:

At joints between concrete construction elements unless otherwise specified; roughened and cleaned surface of set concrete shall be dampened, but not saturated, immediately prior to placing of fresh concrete.

At joints in exposed-to-view work; at vertical joints in walls; at supported slabs, and other structural members; and at joints in work exposed to liquids; the roughened and cleaned surface of set concrete shall be dampened but not saturated and covered with a cement grout coating.

Cement grout shall consist of (b) (7)(E). Cement grout shall be applied with a stiff broom or brush to a minimum thickness (b) (7)(E). Fresh concrete shall be deposited before cement grout has attained its initial set.

Bonding of fresh concrete to concrete that has set may be obtained by use of a concrete bonding agent. Such bonding material shall be applied to cleaned concrete surface in accordance with approved printed instructions of bonding material manufacturer.

### 3.9 FINISHING OF FORMED SURFACES

#### 3.9.1 Repairing and Patching Defective Areas

Immediately after removal of forms, defective areas above finish grade shall be repaired and patched with cement mortar. Honeycomb, rock pockets, voids (b) (7)(E), and holes left by tie rods and bolts shall be cut out to solid concrete, but in no case to a depth of less (b) (7)(E). Edges of cuts shall be perpendicular to surface of concrete. Before placing cement mortar, area to be patched (b) (7)(E) adjacent thereto shall be cleaned, dampened with water, and brush coated with neat Portland cement grout. Cement mortar for patching shall consist of (b) (7)(E) for handling and placing. Portland cement portion of cement mortar shall be a blend of white and standard Portland cement so that when dry, cement mortar will match surrounding concrete in color. Cement mortar shall be compacted in place and struck off slightly higher than the surrounding surface. Holes extending through concrete shall be filled by means of a plunger type gun or other suitable device from unexposed face, using a stop held at exposed face to ensure complete filling.

#### 3.9.2 Standard Rough Form Finish

Formed concrete below finish grade shall be standard rough form finish. Rough finish shall be the concrete surface having texture imparted by form facing material used, defective areas repaired and patched as specified, and fins and other projections exceeding (b) (7)(E) rubbed down with wood blocks.

#### 3.9.3 Standard Smooth Finish

Formed concrete above grade shall be standard smooth finish. Smooth finish shall be as-cast concrete surface as obtained with form facing material for standard smooth finish. Defective areas shall be repaired and patched as specified; and all fins and other projections on surface shall be removed.

#### 3.9.4 Related Unformed Surfaces

Tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck off smooth after concrete is placed and shall be finished to a texture matching that of adjacent formed surfaces. Final surface treatment on formed surfaces shall continue uniformly across adjacent unformed surfaces.

### 3.10 FINISHING OF SLABS AND CHANNELS

#### 3.10.1 Scratch Finish

After placing concrete slabs, surface shall be plane to a tolerance not exceeding (b) (7)(E) placed on the surface at not less than two different angles. Surfaces shall be uniformly sloped to drain. After leveling, surface shall be roughened with stiff brushes or raked before final set.

### 3.11 CONCRETE CURING AND PROTECTION

#### 3.11.1 General

Freshly placed concrete shall be protected from premature drying and cold or hot temperature and shall be maintained without drying at a relatively constant temperature for the period of time necessary for hydration of cement and proper hardening of concrete.

Initial curing shall start as soon as free water has disappeared from surface of concrete after placing and finishing. Concrete shall be kept moist for minimum 72 hours.

Final curing shall immediately follow initial curing and before concrete has dried. Final curing shall continue until cumulative number of hours or fraction thereof (not necessarily consecutive) during which temperature of air in contact with the concrete is above 50 degrees F has totaled 168 hours. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, final curing may be terminated when the average compressive strength has reached 70 percent of the 28-day design compressive strength. Rapid drying at end of final curing period shall be prevented.

### 3.11.2 Curing Methods

Curing shall be accomplished by moist curing, by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as specified.

Moist curing:

Moisture curing shall be accomplished by any of the following methods:

Keeping surface of concrete wet by covering with water

Continuous water spraying

Covering concrete surface with specified absorptive cover for curing concrete saturated with water and keeping absorptive cover wet by water spraying or intermittent hosing. Absorptive cover shall be placed to provide coverage of concrete surfaces and edges with a slight overlap over adjacent absorptive covers.

Moisture-cover curing:

Moisture-retaining cover curing shall be accomplished by covering concrete surfaces with specified moisture-retaining cover for curing concrete. Cover shall be placed directly on concrete in widest practical width, with sides and ends lapped at least 3 inches. Cover shall be weighted to prevent displacement; tears or holes appearing during curing period shall be immediately repaired by patching with pressure-sensitive, waterproof tape or other approved method.

Membrane curing:

Membrane curing shall be accomplished by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared. Curing compound shall be applied uniformly in a two-coat operation by power-spraying equipment using a spray nozzle equipped with a wind guard. Second coat shall be applied in a direction at right angles to direction of first coat. Total coverage for two coats shall be not more than 200 square feet per gallon of curing compound. Concrete surfaces which are subjected to heavy rainfall within 3 hours after curing compound has been applied shall be resprayed by method and at rate specified. Continuity of coating shall be maintained for entire curing period and damage to coating during this period shall be repaired immediately.

Membrane-curing compounds shall not be used on surfaces that are to be covered with coating material applied directly to concrete or with a covering material bonded to concrete, such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, painting, and other coatings and finish materials.

### 3.11.3 Curing Formed Surfaces

Curing of formed surfaces shall be accomplished by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, final curing of formed surfaces shall be accomplished by any of the curing methods specified above, as applicable.

### 3.11.4 Curing Unformed Surfaces

Initial curing of unformed surfaces, such as monolithic slabs/pads shall be accomplished by membrane curing.

Unless otherwise specified, final curing of unformed surfaces shall be accomplished by any of curing methods specified above, as applicable.

### 3.11.5 Temperature of Concrete During Curing

When temperature of atmosphere is 40 degrees F and below, temperature of concrete shall be maintained at not less than 50 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, arrangements shall be made before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which will cause too rapid drying of concrete, arrangements shall be made before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete shall be uniform and shall not exceed 5 degrees F in any 1 hour nor 50 degrees F in any 24-hour period.

### 3.11.6 Protection from Mechanical Injury

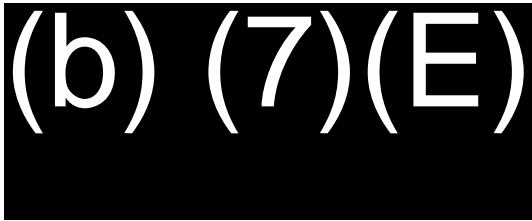
During curing period, concrete shall be protected from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

### 3.11.7 Protection After Curing

Finished concrete surfaces shall be protected from damage by construction operations.

## 3.12 QUALITY-CONTROL TESTING DURING CONSTRUCTION

Concrete shall be sampled and tested for quality control by the Contractor during the placement of the concrete as follows:

<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
Sampling fresh concrete		
Slump test		

(b) (7)(E)

Air content by  
pressure method

Compression test  
specimens

Concrete  
temperature

Compressive  
strength test

Test reports for concrete for Chemical Composition, Mechanical Usability and Soundness shall be submitted by the Contractor meeting all design specifications as required by referenced standards within this section.

### 3.13 INSPECTION AND ACCEPTANCE PROVISIONS

#### 3.13.1 Evaluation of Compressive Strength Tests

Concrete quality control test will be evaluated as specified.

Compressive strength tests will be considered satisfactory if the average of (b) (7)(E)

If compressive strength tests fail to meet minimum requirements specified, concrete represented by such tests will be considered deficient in strength and subject to provisions specified.

### 3.13.2 Strength of Concrete Structure

Strength of concrete structure in place will be considered deficient if it fails to comply with requirements which control strength of structure, including following conditions:

Failure to meet compressive strength tests as evaluated

Reinforcement not conforming to requirements specified

Concrete which differs from required dimensions or location in such a manner as to reduce strength

Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified

Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration

Poor workmanship likely to result in deficient strength

### 3.13.3 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements, cores drilled from hardened concrete for compressive strength determination shall be made in accordance with (b) (7)(E), and as follows:

At least three representative cores shall be taken from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

Cores shall be tested after moisture conditioning in accordance with (b) (7)(E) if concrete they represent will be more than superficially wet under service.

Cores shall be air dried, (60 to 80 degrees F with relative humidity less than 60 percent) for 7 days before test and shall be tested dry if concrete they represent will be dry under service conditions.

Strength of cores from each member or area will be considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.

Core specimens will be taken and tested by the Government. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required shall be borne by the Contractor.

Core holes shall be filled solid with patching mortar and finished to match adjacent concrete surfaces.

Concrete work that is found inadequate by core tests shall be corrected in a manner approved by the Contracting Officer.

SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

(b) (7) (E)

NATIONAL CONCRETE MASONRY ASSOCIATION (NCMA)

(b) (7) (E)

1.2 SUBMITTALS



Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Cold Weather Installation; G

Cold weather construction procedures.

Manufacturer's data sheets on each product to be used; G

Mixing and preparation instructions and recommendations.  
Storage and handling requirements and recommendations  
Installation methods

SD-06 Test Reports

Cementitious components of the grout mix

Grout

Test reports from an approved independent laboratory. Test reports on a previously tested material shall be certified as the same as that proposed for use in this project.

SD-07 Certificates

Admixtures for Grout

Certificates of compliance stating that the materials meet the specified requirements.

1.3 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered, handled, stored, and protected to avoid compromising packages and contact with soil or contaminating material.

1.3.1 Cementitious Materials, Sand and Aggregates

Cementitious and other packaged materials shall be delivered in sealed, unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

1.4 QUALITY ASSURANCE

#### 1.4.1 Spare Vibrator

Maintain at least one spare vibrator on site at all times.

## PART 2 PRODUCTS

### 2.1 GROUT AND READY-MIXED GROUT

Grout shall conform to (b) (7)(E). Cement used in grout shall have a (b) (7)(E). Minimum grout strength shall be (b) (7)(E). Grout shall be used subject to the limitations of Table III. Proportions shall not be changed and materials with different physical or chemical characteristics shall not be used in grout for the work unless additional evidence is furnished that the grout meets the specified requirements. Ready-Mixed grout shall conform to (b) (7)(E).

#### 2.1.1 Admixtures for Grout

In cold weather, a (b) (7)(E) may be used subject to approval; accelerating admixture shall be non-corrosive, shall contain less than (b) (7)(E) and shall conform to (b) (7)(E). In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Contracting Officer.

#### 2.1.2 Grout Mix

(b) (7)(E)

1. (b) (7)(E)
2. (b) (7)(E)
3. (b) (7)(E)
4. (b) (7)(E)
5. (b) (7)(E)
6. (b) (7)(E)

#### 2.1.3 Water

Clean and free from deleterious acids, alkalies, and organic matter.

### 2.2 MIXING

Mixing Procedure: Add factory pre-blended dry materials to water in mortar mixer and mix for at least 5 minutes.

Retempering: Do not retemper grout; discard grout that cannot be easily pumped or poured.

Cold Weather: Follow National Concrete Masonry Association recommendations for cold weather construction.

## PART 3 EXECUTION

### 3.1 PREPARATION

Prior to start of work, verify the applicable conditions as set forth in (b) (7)(E), inspection. The Contracting Officer will serve as inspector.

### 3.2 REBAR

Rebar shall be cleaned of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Rebar shall be placed prior to grouting. Vertical bollard rebar shall extend as shown on the drawings.

#### 3.2.1 Positioning Bars

Vertical bars shall be accurately placed within the bollards at the positions indicated on the drawings. A minimum clearance of (b) (7)(E) shall be maintained between the bars and bollard walls. Vertical rebars may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than (b) (7)(E) of the reinforcement.

#### 3.2.2 Splices

Bars shall be lapped a minimum of (b) (7)(E) of the reinforcement. Welded or mechanical connections shall develop at least (b) (7)(E) of the specified yield strength of the reinforcement.

### 3.3 PLACING GROUT

(b) (7)(E). Grout not in place within 1-1/2 hours after water is first added to the batch shall be discarded. Sufficient grout shall be provided (b) (7)(E).

#### 3.3.1 Grouting Equipment

##### 3.3.1.1 Grout Pumps

Pumping through aluminum tubes will not be permitted. Pumps shall be operated to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, waste materials and debris shall be removed from the equipment, and disposed of.

##### 3.3.1.2 Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. At least one spare vibrator shall be maintained at the site at all times. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing segregation.

##### 3.3.2 Grout Placement

Grout shall be placed using a grout pump to completely fill the grout space without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state.

### 3.4 WASTE MANAGEMENT

Manage waste according to the Waste Management Plan and as follows. Minimize water used to wash mixing equipment. Use trigger operated spray nozzles for water hoses.

#### 3.4.1 Separate and Recycle Waste

Place materials defined as hazardous or toxic waste in designated containers. Fold up metal banding, flatten, and place in designated area for recycling. Collect wood packing shims and pallets and place in designated area. Use leftover mixed mortar as directed where lower strength mortar meets the requirements for bulk fill. Separate masonry waste and place in designated area for use as structural fill. Separate selected masonry waste and excess for landscape uses, either whole or crushed as ground cover.

### 3.5 TEST REPORTS

#### 3.5.1 Field Testing of Grout

Field sampling and testing of grout shall be in accordance with the applicable provisions of (b) (7)(E). A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of (b) (7)(E).

--End of Section--

SECTION 05 05 23

WELDING, STRUCTURAL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

(b) (7)(E)

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

(b) (7)(E)

AMERICAN WELDING SOCIETY (AWS)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

1.2 DEFINITIONS

Definitions of welding terms are in accordance with (b) (7)(E). The following classifications Class 1 (highest class) to Class 6 (lowest class) indicate the project's class(es) of weld joints.

#### 1.2.1 Class 1 Weld Joints

This covers complete penetration weld joints only. These weld joints apply where failure would cause a loss of the system and/or be hazardous to personnel. Class 1 weld joints are highly stressed (dynamic and cyclic loading) and characterized as a single point of failure with no redundancy for the redistribution of stress into another member.

#### 1.2.2 Class 2 Weld Joints

This covers both complete and partial penetration groove weld joints and fillet weld joints. These weld joints apply where failure would reduce the overall efficiency of a system but loss of the system or a hazard to personnel would not be experienced.

#### 1.2.3 Class 3 Weld Joints

This covers both complete and partial penetration groove weld joints and fillet weld joints. These weld joints apply where failure would not affect the efficiency of a system nor create a hazard to personnel. Class 3 weld joints are connections of secondary members not subject to dynamic action and/or low stressed miscellaneous applications.

#### 1.2.4 Class 4 Weld Joints

This covers weld joints applicable to welding reinforcing steel to primary structural members.

#### 1.2.5 Class 5 Weld Joints

This covers weld joints applicable to welding concrete reinforcing steel splices (prestressing steel excepted), steel connection devices, and inserts and anchors required in concrete construction.

#### 1.2.6 Class 6 Weld Joints

This covers plug and slot weld joints as applicable to the requirements of the project's code(s).

### 1.3 GENERAL REQUIREMENTS

Conform the design of welded connections to (b) (7)(E), unless otherwise indicated or specified. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Perform welding as specified in this section, except where additional requirements are shown on the drawings or are specified in other sections. Do not commence welding until welding procedures, inspectors, nondestructive testing personnel, welders, welding operators, and tackers have been qualified and the submittals approved by the Contracting Officer. Perform all testing at or near the work site. Each Contractor performing welding shall maintain records of the test results obtained in welding procedure, welder, welding operator, and tacker performance qualifications.

#### 1.3.1 Pre-erection Conference

Hold a pre-erection conference prior to the start of the field welding, to bring all affected parties together and to gain a naturally clear understanding of the project and the Welding Procedure Specifications (WPS) (which the Contractor shall develop and submit for all welding, including welding done using pre-qualified procedures). Mandatory attendance is required by all Contractor's welding production and inspection personnel and appropriate Government personnel. Include as items for discussion: responsibilities of various parties; welding procedures and processes to be followed; welding sequence

(both within a joint and joint sequence within the building); inspection requirements and procedures, both visual and ultrasonic; welding schedule; fabrication of mock-up model; and other items deemed necessary by the attendees.

#### 1.3.2 Mock-up Model

Perform first the field-welded connection designated as the mock-up model on the drawings. All welders qualified and designated to perform field-welded groove joints must be present during the welding of the mock-up model connections and each one shall perform a part of the welding. Simulate with the mock-up test all physical and environmental conditions that will be encountered during the welding of all groove joints. Execute all inspection procedures required for groove welded joints, including NDE tests, on the mock-up model. All Contractor inspection and testing personnel designated to perform QC of groove welded joints must be present during the welding of the mock-up model and each one shall perform the inspection procedures to be performed on production welding of these joints. This mock-up model connection represents the standard of performance, both for the welding and inspection procedures used and the results to be achieved in the production welding for these groove welded joints.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

##### SD-03 Product Data

Welding Procedure Qualifications; G  
Welder, Welding Operator, and Tacker Qualification  
Inspector Qualification  
Previous Qualifications  
Pre-qualified Procedures

Copies of the welding procedure specifications; the procedure qualification test records; and the welder, welding operator, or tackler qualification test records.

##### SD-06 Test Reports

Quality Control  
Nondestructive Examination

A quality assurance plan and records of tests and inspections. Submit all records of nondestructive examination in accordance with paragraph "Acceptance Requirements".

##### SD-07 Certificates

Certified Welding Procedure Specifications (WPS)  
Certified Brazing Procedure Specifications (BPS)  
Certified Procedure Qualification Records (PQR)  
Certified Welder Performance Qualifications (WPQ)  
Certified Brazer Performance Qualifications (BPQ)

Certificates in accordance with paragraph "Other Applications".



## 1.5 WELDING PROCEDURE QUALIFICATIONS

Except for pre-qualified (b) (7)(E) and previously qualified procedures, each Contractor performing welding shall record in detail and qualify the welding procedure specification for any welding procedure followed in the fabrication of weldments. Conform qualification of welding procedures to (b) (7)(E) and to the specifications in this section. Submit for approval copies of the welding procedure specification and the results of the procedure qualification test for each type of welding which requires procedure qualification. Approval of any procedure, however, does not relieve the Contractor of the sole responsibility for producing a finished structure meeting all the specified requirements. Submit this information on the forms in Appendix E of (b) (7)(E). Individually identify and clearly reference on the detail drawings and erection drawings all welding procedure specifications, or suitably key them to the contract drawings. In case of conflict between this specification and (b) (7)(E), this specification governs.

### 1.5.1 General Requirements

The organization performing this work must be certified in the following: American Institute of Steel Construction (AISC) Quality Certification Program Category I Conventional Steel Structures.

a. For Structural Projects, provide documentation of the following:

- 1) Component Thickness (b) (7)(E) Qualification documents (WPS, PQR, and WPQ) in accordance with (b) (7)(E).
- 2) Component Thickness (b) (7)(E) Qualification documents (WPS, PQR, and WPQ) in accordance with (b) (7)(E).
- 3) Reinforcing Steel: Qualification documents (b) (7)(E) in accordance with (b) (7)(E).

b. For other applications, provide documentation of the following:

- 1) Submit for review to the Contracting Officer two copies of Certified Welding Procedure Specifications (WPS), Certified Brazing Procedure Specifications (BPS) and Certified Procedure Qualification Records (PQR) within fifteen calendar days after receipt of Notice to Proceed.
- 2) Cranes: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS (b) (7)(E).
- 3) Submit for review to the Contracting Officer two copies of Certified Welder Performance Qualifications (WPQ) and Certified Brazer Performance Qualifications (BPQ) within fifteen calendar days prior to any employee welding on the project material.
- 4) Machinery: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS (b) (7)(E).

### 1.5.2 Previous Qualifications

Welding procedures previously qualified by test may be accepted for this contract without re-qualification if the following conditions are met:

- a. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.
- b. The qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.
- c. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

#### 1.5.3 Pre-qualified Procedures

Welding procedures which are considered pre-qualified as specified in (b) (7)(E) will be accepted without further qualification. The Contractor shall submit for approval a listing or an annotated drawing to indicate the joints not pre-qualified. Procedure qualification is mandatory for these joints.

#### 1.5.4 Retests

If welding procedure fails to meet the requirements of (b) (7)(E), the procedure specification must be revised and re-qualified, or at the Contractor's option, welding procedure may be retested in accordance with (b) (7)(E). If the welding procedure is qualified through retesting, all test results, including those of test welds that failed to meet the requirements, must be submitted with the welding procedure.

### 1.6 WELDER, WELDING OPERATOR, AND TACKER QUALIFICATION

Each welder, welding operator, and tacker assigned to work on this contract must be qualified in accordance with the applicable requirements of (b) (7)(E) and as specified in this section. Welders, welding operators, and tackers who make acceptable procedure qualification test welds will be considered qualified for the welding procedure used.

#### 1.6.1 Previous Personnel Qualifications

At the discretion of the Contracting Officer, welders, welding operators, and tackers qualified by test within the previous 6 months may be accepted for this contract without re-qualification if all the following conditions are met:

- a. Copies of the welding procedure specifications, the procedure qualification test records, and the welder, welding operator, and tacker qualification test records are submitted and approved in accordance with the specified requirements for detail drawings.
- b. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.
- c. The previously qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.
- d. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

#### 1.6.2 Certificates

Before assigning any welder, welding operator, or tacker to work under this contract, submit the names of the welders, welding operators, and tackers to be employed, and certification that each individual is

qualified as specified. The certification must state the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is qualified, the date qualified, and the name of the firm and person certifying the qualification tests. Keep the certification current, on file, and furnish 3 copies.

#### 1.6.3 Renewal of Qualification

Re-qualification of a welder or welding operator is required under any of the following conditions:

- a. It has been more than 6 months since the welder or welding operator has used the specific welding process for which he is qualified.
- b. There is specific reason to question the welder or welding operator's ability to make welds that meet the requirements of these specifications.
- c. The welder or welding operator was qualified by an employer other than those firms performing work under this contract, and a qualification test has not been taken within the past 12 months. Submit as evidence of conformance all records showing periods of employment, name of employer where welder, or welding operator, was last employed, and the process for which qualified.
- d. A tacker who passes the qualification test is considered eligible to perform tack welding indefinitely in the positions and with the processes for which he is qualified, unless there is some specific reason to question the tacker's ability. In such a case, the tacker is required to pass the prescribed tack welding test.

#### 1.7 INSPECTOR QUALIFICATION

Inspector qualifications must be in accordance with (b) (7)(E). Qualify all nondestructive testing personnel in accordance with the requirements of (b) (7)(E) for Levels I or II in the applicable nondestructive testing method. The inspector may be supported by assistant welding inspectors who are not qualified to (b) (7)(E), and assistant inspectors may perform specific inspection functions under the supervision of the qualified inspector.

#### 1.8 SYMBOLS

Symbols must be in accordance with (b) (7)(E), unless otherwise indicated.

#### 1.9 SAFETY

Safe weldiing practices and safety precautions during welding must conform to (b) (7)(E).

### PART 2 PRODUCTS

#### 2.1 WELDING EQUIPMENT AND MATERIALS

All welding equipment, electrodes, welding wire, and fluxes must be capable of producing satisfactory welds when used by a qualified welder or welding operator performing qualified welding procedures. All welding equipment and materials shall comply with the applicable requirements of (b) (7)(E).

### PART 3 EXECUTION

#### 3.1 WELDING OPERATIONS

### 3.1.1 Requirements

Conform workmanship and techniques for welded construction to the requirements of (b) (7)(E)

### 3.1.2 Identification

Identify all welds in one of the following ways:

- a. Submit written records to indicate the location of welds made by each welder, welding operator, or tacker.
- b. Identify all work performed by each welder, welding operator, or tacker with an assigned number, letter, or symbol to identify welds made by that individual. The Contracting Officer may require welders, welding operators, and tackers to apply their symbol next to the weld by means of rubber stamp, felt-tipped marker with waterproof ink, or other methods that do not cause an indentation in the metal. Place the identification mark for seam welds adjacent to the weld at (b) (7)(E) intervals. Identification with die stamps or electric etchers is not allowed.

## 3.2 QUALITY CONTROL

Perform testing using an approved inspection or testing laboratory or technical consultant; or if approved, the Contractor's inspection and testing personnel may be used instead of the commercial inspection or testing laboratory or technical consultant. Perform visual and ultrasonic or radiographic inspections to determine conformance with paragraph STANDARDS OF ACCEPTANCE. Conform procedures and techniques for inspection with applicable requirements of (b) (7)(E) except that in radiographic inspection only film types designated as "fine grain," or "extra fine," are acceptable.

## 3.3 STANDARDS OF ACCEPTANCE

Conform dimensional tolerances for welded construction, details of welds, and quality of welds with the applicable requirements of (b) (7)(E) and the contract drawings. Perform nondestructive testing by visual inspection and radiographic or ultrasonic methods. The minimum extent of nondestructive testing must be random (b) (7)(E) of welds or joints, as indicated on the drawings.

### 3.3.1 Nondestructive Examination

The welding is subject to inspection and tests in the mill, shop, and field. Inspection and tests in the mill or shop do not relieve the Contractor of the responsibility to furnish weldments of satisfactory quality. When materials or workmanship do not conform to the specification requirements, the Government reserves the right to reject material or workmanship or both at any time before final acceptance of the structure containing the weldment.

### 3.3.2 Destructive Tests

Make all repairs when metallographic specimens are removed from any part of a structure. Employ only qualified welders or welding operators, and use the proper joints and welding procedures, including peening or heat treatment if required, to develop the full strength of the members and joints cut and to relieve residual stress.

### 3.4 GOVERNMENT INSPECTION AND TESTING

In addition to the inspection and tests performed by the Contractor for quality control, the Government will perform inspection and testing for acceptance to the extent determined by the Contracting Officer. The costs of such inspection and testing will be borne by the Contractor if unsatisfactory welds are discovered, or by the Government if the welds are satisfactory. The work may be performed by the Government's own forces or under a separate contract for inspection and testing. The Government reserves the right to perform supplemental nondestructive and destructive tests to determine compliance with paragraph STANDARDS OF ACCEPTANCE.

### 3.5 CORRECTIONS AND REPAIRS

If inspection or testing indicates defects in the weld joints, repair defective welds using a qualified welder or welding operator as applicable. Conduct corrections in accordance with the requirements of (b) (7)(E) and the specifications. Repair all defects in accordance with the approved procedures. Repair defects discovered between passes before additional weld material is deposited. Wherever a defect is removed and repair by welding is not required, blend the affected area into the surrounding surface to eliminate sharp notches, crevices, or corners. After a defect is thought to have been removed, and before re-welding, examine the area by suitable methods to ensure that the defect has been eliminated. Repaired welds shall meet the inspection requirements for the original welds. Any indication of a defect is regarded as a defect, unless re-evaluation by nondestructive methods or by surface conditioning shows that no unacceptable defect is present.

-- End of Section --

SECTION 05 12 00

STRUCTURAL STEEL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

(b) (7)(E)

AMERICAN WELDING SOCIETY (AWS)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

(b) (7)(E)



(b) (7)(E)

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

(b) (7)(E)

#### 1.2 SYSTEM DESCRIPTION

Provide the structural steel for fencing system and any required shop primed or galvanized steel, complete and ready for use. Structural steel works shall include specified design, materials, installation, workmanship, fabrication, assembly, inspection, quality control, and testing in accordance with (b) (7)(E) and (b) (7)(E) except as modified in this contract.

#### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

##### SD-02 Shop Drawings

Erection Plan, including description of temporary supports; G

Fabrication drawings including description of connections; G

##### SD-03 Product Data

Welding electrodes and rods

##### SD-06 Test Reports

Bolts, nuts, and washers

Supply the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

##### SD-07 Certificates

Steel

Bolts, nuts, and washers

Galvanizing



## AISC Quality Certification

### Welding procedures and qualifications

#### 1.4 AISC QUALITY CERTIFICATION

Work shall be fabricated in an AISC certified Category STD fabrication plant.

#### 1.5 SEISMIC PROVISIONS

The structural steel system shall be provided in accordance with (b) (7)(E).

#### 1.6 QUALITY ASSURANCE

##### 1.6.1 Drawing Requirements

As applicable, submit fabrication drawings for approval prior to fabrication. Prepare in accordance with (b) (7)(E). Fabrication drawings shall not be reproductions of contract drawings. Sign and seal fabrication drawings by a professional engineer registered in the State where the project is located. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use (b) (7)(E) standard welding symbols. Shoring and temporary bracing shall be designed and sealed by a registered professional engineer and submitted for record purposes, with calculations, as part of the drawings. Member substitutions of details shown on the contract drawings shall be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

Provide connection, forming and stiffening details for Structural Steel. Avoid ledges, crevices and pockets that hold water, water-laden debris or condensation.

##### 1.6.2 Certifications

###### 1.6.2.1 Erection Plan

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing, and a detailed sequence of welding, including each welding procedure required.

###### 1.6.2.2 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welding operator is more than one-year old, the welding operator's qualification certificate shall be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.

Conform to all requirements specified in (b) (7)(E).

## PART 2 PRODUCTS

### 2.1 STEEL

#### 2.1.1 Fence Picket Bars

(b) (7)(E) Structural Steel, sizes as shown on drawings.  
Pickets shall be fabricated (b) (7)(E).

#### 2.1.2 Tube Steel (Bollards)

(b) (7)(E) sizes as shown on drawings

#### 2.1.4 WF Columns, Beams, and Rail

(b) (7)(E), Structural wide flange sizes as shown on the drawings

#### 2.1.6 Plates, Bars and Angles

(b) (7)(E), Structural Steel, Structural sizes as shown on the drawings

#### 2.1.7 Sheathing

(b) (7)(E) for Sheathing and Miscellaneous Brackets

#### 2.1.8 Steel Pipe

(b) (7)(E) sizes as shown on drawings

### 2.2 BOLTS, NUTS, AND WASHERS

Provide the following unless indicated otherwise.

#### 2.2.1 Structural Steel, Steel Pipe

##### 2.2.1.1 Bolts

(b) (7)(E) The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

##### 2.2.1.2 Nuts

(b) (7)(E), Grade and Style for applicable ASTM bolt standard recommended.

##### 2.2.1.3 Washers

(b) (7)(E).

#### 2.2.2 High-Strength Structural Steel and Structural Steel Tubing

##### 2.2.2.1 Bolts

(b) (7)(E)

#### 2.2.2.2 Nuts

(b) (7)(E)

#### 2.2.2.3 Washers

(b) (7)(E)

### 2.3 FENCE PANELS

(b) (7)(E)

(b) (7)(E)

#### 2.3.2 Perforated Plate

(b) (7)(E)

## 2.4 STRUCTURAL STEEL ACCESSORIES

### 2.4.1 Welding Electrodes and Rods

(b) (7)(E) electrodes as specified by the American Welding Society for welding Weathering Steel. Suggestions on minimum preheat are contained in the latest revisions of (b) (7)(E)

When matching strength is required, and color match and corrosion resistance are not important, (b) (7)(E) electrodes may be used. These electrodes also work for the underlying passes in multiple-pass welds.

## 2.5 SHOP PRIMER

See Paint Section 09 90 00.

## 2.6 GALVANIZING

Connection elements (bolts, connection brackets, etc) shall be Galvanized in accordance with (b) (7)(E) (b) (7)(E) Unless specified otherwise galvanize after fabrication where practicable.

## 2.7 FABRICATION

### 2.7.1 Markings

Prior to erection, members shall be identified by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections shall be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded. Do not locate match markings in areas that will decrease member strength or cause stress concentrations.

### 2.7.2 Cleaning

(b) (7)(E) Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

## 2.8 DRAINAGE HOLES

Adequate drainage holes shall be drilled to eliminate water traps. Hole diameter shall be (b) (7)(E) and location shall be indicated on the detail drawings. Hole size and location shall not affect the structural integrity.

## PART 3 EXECUTION

### 3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of (b) (7)(E). Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC FCD for Category STD structural steelwork.

Compression joints depending on contact bearing shall have a surface roughness not in excess of (b) (7)(E) as determined by (b) (7)(E), and ends shall be square within the tolerances for milled ends specified in (b) (7)(E).

Structural steelwork, except weathering steel, surfaces of steel to be encased in concrete, surfaces to be field welded, shall be prepared for painting in accordance with endorsement "P" of AISC FCD and primed with the specified paint.

Shop splices of members between field splices will be permitted only where indicated on the Contract Drawings. Splices not indicated require the approval of the Contracting Officer.

### 3.2 ERECTION

Erection of structural steel shall be in accordance with the applicable provisions of (b) (7)(E) or endorsement (b) (7)(E). Erection plan shall be reviewed, stamped and sealed by a licensed structural engineer.

Provide for drainage in structural steel. After final positioning of steel members, (b) (7)(E) (b) (7)(E).

#### 3.2.1 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

### 3.3 CONNECTIONS

Except as modified in this section, connections not detailed shall be designed in accordance with (b) (7)(E) (b) (7)(E).

#### 3.3.1 Common Grade Bolts

(b) (7)(E) bolts shall be tightened (b) (7)(E)  
contact the Contracting Officer for further instructions.

### 3.4 GAS CUTTING

Use of gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officers.

### 3.5 WELDING

(b) (7)(E) except as follows.

(b) (7)(E)

(b) (7)(E)

Welding shall be consistent with AWS recommended procedures including adequate edge preparation and preheating, the selection of proper flux (when applicable) and the use of properly dried, low-hydrogen electrodes and fluxes.

Grind exposed welds smooth as indicated. Provide (b) (7)(E) qualified welders, welding operators, and tackers.

The Contractor shall develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Prequalified procedures may be submitted for information only; however, procedures that are not prequalified shall be submitted for approval.

#### 3.5.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips

Remove only from finished areas.

### 3.6 SHOP PRIMER REPAIR

See Paint Section 09 90 00.

### 3.7 GALVANIZING REPAIR

Provide as indicated or specified. Galvanize after fabrication where practicable. Repair damage to galvanized coatings using (b) (7)(E) paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

### 3.8 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing. The Contracting Officer shall be notified in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of weld inspection.

### 3.8.1 Welds

#### 3.8.1.1 Visual Inspection

(b) (7)(E) Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections. Welding inspectors shall visually inspect and mark welds, including fillet weld end returns.

#### 3.8.1.2 Nondestructive Testing

(b) (7)(E) Test locations shall be as indicated. If more than 20 percent of welds made by a welder contain defects identified by testing, then all welds made by that welder shall be tested by radiographic or ultrasonic testing, as approved by the Contracting Officer. When all welds made by an individual welder are required to be tested, magnetic particle testing shall be used only in areas inaccessible to either radiographic or ultrasonic testing. Retest defective areas after repair.

Testing frequency: (b) (7)(E) framing. Testing frequency will be increased if visual inspections reveal that welds are suspect.

Nondestructive testing shall be performed by AWS-certified inspectors only.

### 3.8.2 Testing for Embrittlement

(b) (7)(E) for steel products hot-dip galvanized after fabrication.

-- End of Section -

SECTION 09 90 00

PAINTS AND COATINGS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

ASTM D 523 (2008) Standard Test Method for Specular Gloss

MASTER PAINTERS INSTITUTE (MPI)

MPI 101 (Oct 2009) Epoxy Anti-Corrosive Metal Primer

MPI 107 (Oct 2009) Rust Inhibitive Primer (Water-Based)

MPI 108 (Oct 2009) High Build Epoxy Coating, Low Gloss

MPI 164 (Oct 2009) Exterior W.B. Light Industrial Coating, Gloss, MPI Gloss Level 6

MPI 23 (Oct 2009) Surface Tolerant Metal Primer

MPI 79 (Oct 2009) Alkyd Anti-Corrosive Metal Primer

MPI 9 (Oct 2009) Exterior Alkyd, Gloss, MPI Gloss Level 6

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1 (2000; E 2004) Shop, Field, and Maintenance Painting

SSPC PA Guide 3 (1982; E 1995) A Guide to Safety in Paint Application

SSPC SP 1 (1982; E 2004) Solvent Cleaning

SSPC SP 10 (2007) Near-White Blast Cleaning

SSPC SP 12 (2002) Surface Preparation and Cleaning of Metals by Water jetting Prior to Recoating

SSPC SP 2 (1982; E 2004) Hand Tool Cleaning

SSPC SP 3 (2004; E 2004) Power Tool Cleaning

SSPC SP 6	(2007) Commercial Blast Cleaning
SSPC SP 7	(2007) Brush-Off Blast Cleaning
SSPC VIS 1	(2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
SSPC VIS 3	(2004) Visual Standard for Power-and Hand-Tool Cleaned Steel
SSPC VIS 4	(1998; E 2000; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Water jetting

#### U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2008) Safety and Health Requirements Manual
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#### U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-313	(Rev D; Am 1) Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities
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#### U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants
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### 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 0133.00 SUBMITTAL PROCEDURES:

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

Samples of specified materials may be taken and tested for compliance with specification requirements.

#### SD-02 Shop Drawings

Piping identification

Submit color stencil codes

#### SD-03 Product Data

Coating



## Manufacturer's Technical Data Sheets

### Sealant

#### SD-04 Samples

##### Color

Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated.

#### SD-07 Certificates

##### Applicator's qualifications

##### Qualification Testing laboratory for coatings

#### SD-08 Manufacturer's Instructions

##### Application instructions

##### Mixing

Detailed mixing instructions, minimum and maximum application temperature and humidity, potlife, and curing and drying times between coats.

##### Manufacturer's Material Safety Data Sheets

Submit manufacturer's Material Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

#### SD-10 Operation and Maintenance Data

##### Coatings

Preprinted cleaning and maintenance instructions for all coating systems shall be provided.

#### SD-11 Closeout Submittals

## Materials

### 1.3 APPLICATOR'S QUALIFICATIONS

#### 1.3.1 Contractor Qualification

Submit the name, address, telephone number, FAX number, and e-mail address of the contractor that will be performing all surface preparation and coating application. Submit evidence that key personnel have successfully performed surface preparation and application of coatings on a minimum of three similar projects within the past three years. List information by individual and include the following:

a. Name of individual and proposed position for this work.

b. Information about each previous assignment including:

Position or responsibility

Employer (if other than the Contractor)

Name of facility owner

Mailing address, telephone number, and telex number (if non-US) of facility owner

Name of individual in facility owner's organization who can be contacted as a reference

Location, size and description of structure

Dates work was carried out

Description of work carried out on structure

#### 1.4 QUALITY ASSURANCE

##### 1.4.1 Field Samples and Tests

The Contracting Officer may choose up to two coatings that have been delivered to the site to be tested at no cost to the Government. Take samples of each chosen product as specified in the paragraph "Sampling Procedures." Test each chosen product as specified in the paragraph "Testing Procedure." Products which do not conform, shall be removed from the job site and replaced with new products that conform to the referenced specification. Testing of replacement products that failed initial testing shall be at no cost to the Government.

##### 1.4.1.1 Sampling Procedure

The Contracting Officer will select paint at random from the products that have been delivered to the job site for sample testing. The Contractor shall provide samples of the selected paint materials. The samples shall be taken in the presence of the Contracting Officer, and labeled, identifying each sample. Provide labels in accordance with the paragraph "Packaging, Labeling, and Storage" of this specification.

##### 1.4.1.2 Testing Procedure

Provide Batch Quality Conformance Testing for specified products, as defined by and performed by MPI. As an alternative to Batch Quality Conformance Testing, the Contractor may provide Qualification Testing for specified products above to the appropriate MPI product specification, using the third-party laboratory approved under the paragraph "Qualification Testing" laboratory for coatings. The qualification testing lab report shall include the backup data and summary of the test results. The summary shall list all of the reference specification requirements and the result of each test. The summary shall clearly indicate whether the tested paint meets each test requirement. Note that Qualification Testing may take 4 to 6 weeks to perform, due to the extent of testing required.

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified. If the Contractor chooses MPI to perform the Batch Quality Conformance testing, the above submittal information is not required, only a letter is required from the Contractor stating that MPI will perform the testing.

## 1.5 REGULATORY REQUIREMENTS

### 1.5.1 Environmental Protection

In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local Air Pollution Control District and regional jurisdiction. Notify Contracting Officer of any paint specified herein which fails to conform.

### 1.5.2 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content.

### 1.5.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

### 1.5.4 Asbestos Content

Materials shall not contain asbestos.

### 1.5.5 Mercury Content

Materials shall not contain mercury or mercury compounds.

### 1.5.6 Silica

Abrasive blast media shall not contain free crystalline silica.

### 1.5.7 Human Carcinogens

Materials shall not contain ACGIH 0100Doc and ACGIH 0100Doc confirmed human carcinogens (A1) or suspected human carcinogens (A2).

## 1.6 PACKAGING, LABELING, AND STORAGE

Paints shall be in sealed containers that legibly show the contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Pigmented paints shall be furnished in containers not larger than 5 gallons. Paints and thinners shall be stored in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 40 to 95 degrees F.

## 1.7 SAFETY AND HEALTH

Apply coating materials using safety methods and equipment in accordance with the following:

Work shall comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS and in Appendix A of EM 385-1-1. The Activity Hazard Analysis shall include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

#### 1.7.1 Safety Methods Used During Coating Application

Comply with the requirements of SSPC PA Guide 3.

#### 1.7.2 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

- a. The applicable manufacturer's Material Safety Data Sheets (MSDS) or local regulation.
- b. 29 CFR 1910.1000.
- c. ACGIH 0100Doc, threshold limit values.

#### 1.8 ENVIRONMENTAL CONDITIONS

Comply, at minimum, with manufacturer recommendations for space ventilation during and after installation.

##### 1.8.1 Coatings

Do not apply coating when air or substrate conditions are:

- a. Less than 5 degrees F above dew point;
- b. Below 50 degrees F or over 95 degrees F, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Under no circumstances shall application conditions exceed manufacturer recommendations.

#### 1.9 COLOR SELECTION

Colors of finish coats shall be as indicated or specified. Where not indicated or specified, colors shall be selected by the Contracting Officer. Manufacturers' names and color identification are used for the purpose of color identification only. Named products are acceptable for use only if they conform to specified requirements. Products of other manufacturers are acceptable if the colors approximate colors indicated and the product conforms to specified requirements.

Tint each coat progressively darker to enable confirmation of the number of coats.

#### 1.10 LOCATION AND SURFACE TYPE TO BE PAINTED

##### 1.10.1 Painting Included

This specification only applies to the Picket Style Primary Fence being installed for alignment RGV SEGMENT 017.

#### 1.10.1.1 Exterior Painting

Includes new surfaces, existing coated surfaces, and existing uncoated surfaces, of the Picket Style Primary Fence. Also included are existing coated surfaces made bare by cleaning operations.

#### 1.10.2 Painting Excluded

Do not paint the following unless indicated otherwise.

- a. Steel to be embedded in concrete.

#### 1.10.3 Exterior Painting of Site Work Items

Field coat the following items:

New Surfaces

- a. Picket Style Primary Fence

#### 1.10.4 Definitions and Abbreviations

##### 1.10.4.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

##### 1.10.4.2 Batch Quality Conformance Testing

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing shall only be accomplished by MPI testing lab.

##### 1.10.4.3 Coating

A film or thin layer applied to a base material called a substrate. A coating may be a metal, alloy, paint, or solid/liquid suspensions on various substrates (metals, plastics, wood, paper, leather, cloth, etc.). They may be applied by electrolysis, vapor deposition, vacuum, or mechanical means such as brushing, spraying, calendaring, and roller coating. A coating may be applied for aesthetic or protective purposes or both. The term "coating" as used herein includes emulsions, enamels, stains, varnishes, sealers, epoxies, and other coatings, whether used as primer, intermediate, or finish coat. The terms paint and coating are used interchangeably.

##### 1.10.4.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

##### 1.10.4.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five (5) levels are generically defined under the Assessment sections in the MPI Maintenance Repainting Manual.

#### 1.10.4.6 EPP

Environmentally Preferred Products, a standard for determining environmental preferability in support of Executive Order 13101.

#### 1.10.4.7 EXT

MPI short term designation for an exterior coating system.

#### 1.10.4.8 INT

MPI short term designation for an interior coating system.

#### 1.10.4.9 micron / microns

The metric measurement for 0.001 mm or one/one-thousandth of a millimeter.

#### 1.10.4.10 mil / mils

The English measurement for 0.001 in or one/one-thousandth of an inch, equal to 25.4 microns or 0.0254 mm.

#### 1.10.4.11 mm

The metric measurement for millimeter, 0.001 meter or one/one-thousandth of a meter.

#### 1.10.4.12 MPI Gloss Levels

MPI system of defining gloss. Seven (7) gloss levels (G<sub>1</sub> to G<sub>7</sub>) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G<sub>1</sub>/G<sub>2</sub>, Eggshell refers to G<sub>3</sub>, Semigloss refers to G<sub>5</sub>, and Gloss refers to G<sub>6</sub>.

Gloss levels are defined by MPI as follows:

Gloss Level	Description	Units @ 60 degrees	Units @ 85 degrees
G <sub>1</sub>	Matte or Flat	0 to 5	10 max
G <sub>2</sub>	Velvet	0 to 10	10 to 35
G <sub>3</sub>	Eggshell	10 to 25	10 to 35
G <sub>4</sub>	Satin	20 to 35	35 min
G <sub>5</sub>	Semi-Gloss	35 to 70	
G <sub>6</sub>	Gloss	70 to 85	
G <sub>7</sub>	High Gloss		

Gloss is tested in accordance with ASTM D 523. Historically, the Government has used Flat (G<sub>1</sub> / G<sub>2</sub>), Eggshell (G<sub>3</sub>), Semi-Gloss (G<sub>5</sub>), and Gloss (G<sub>6</sub>).

#### 1.10.4.13 MPI System Number

The MPI coating system number in each Division found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN). The Division number follows the CSI Master Format.

#### 1.10.4.14 Paint

See Coating definition.

#### 1.10.4.15 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

#### 1.10.4.16 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer's technical data sheets for specified coatings and solvents. Comply with applicable regulations regarding toxic and hazardous materials.

### PART 3 EXECUTION

#### 3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect, hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

#### 3.2 SURFACE PREPARATION

Remove dirt, splinters, loose particles, grease, oil, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

##### 3.2.1 Existing Coated Surfaces with Minor Defects

Sand, spackle, and treat minor defects to render them smooth. Minor defects are defined as scratches, nicks, cracks, gouges, spalls, alligatoring, chalking, and irregularities due to partial peeling of previous coatings.

### 3.2.2 Removal of Existing Coatings

Remove existing coatings from the following surfaces:

- a. Surfaces designated by the Contracting Officer, such as surfaces where rust shows through existing coatings.

## 3.3 PREPARATION OF METAL SURFACES

### 3.3.1 Existing and New Ferrous Surfaces

- a. Ferrous Surfaces including Shop-coated Surfaces and Small Areas That Contain Rust, Mill Scale and Other Foreign Substances: Solvent clean or detergent wash in accordance with SSPC SP 1 to remove oil and grease. Where shop coat is missing or damaged, clean according to SSPC SP 2, SSPC SP 3, SSPC SP 6, or SSPC SP 10. Brush-off blast remaining surface in accordance with SSPC SP 7; Water jetting to SSPC SP 12 WJ-4 may be used to remove loose coating and other loose materials. Use inhibitor as recommended by coating manufacturer to prevent premature rusting. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.
- b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with SSPC SP 6/SSPC SP 12 WJ-3 or SSPC SP 10/SSPC SP 12 WJ-2.

### 3.3.2 Final Ferrous Surface Condition:

For tool cleaned surfaces, the requirements are stated in SSPC SP 2 and SSPC SP 3. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 3.

For abrasive blast cleaned surfaces, the requirements are stated in SSPC SP 7, SSPC SP 6, and SSPC SP 10. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 1.

For waterjet cleaned surfaces, the requirements are stated in SSPC SP 12. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 4.

## 3.4 APPLICATION

### 3.4.1 Coating Application

Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates, except as modified herein.

At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application.

Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Use trigger operated spray nozzles for water hoses. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Wear protective clothing and respirators when applying oil-based paints or using spray equipment with any paints.



Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

Thoroughly work coating materials into joints, crevices, and open spaces. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.

Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete.

Touch up damaged coatings before applying subsequent coats.

- a. **Drying Time:** Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.
- b. **Primers, and Intermediate Coats:** Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Each coat shall cover surface of preceding coat or surface completely, and there shall be a visually perceptible difference in shades of successive coats.
- c. **Finished Surfaces:** Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.
- d. **Thermosetting Paints:** Topcoats over thermosetting paints (epoxies and urethanes) should be applied within the overcoating window recommended by the manufacturer.

#### 3.4.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. The written permission shall include quantities and types of thinners to use.

When thinning is allowed, paints shall be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

#### 3.4.3 Two-Component Systems

Two-component systems shall be mixed in accordance with manufacturer's instructions. Any thinning of the first coat to ensure proper penetration and sealing shall be as recommended by the manufacturer for each type of substrate.

#### 3.4.4 Coating Systems

- a. **Systems by Substrates:** Apply coatings that conform to the respective specifications listed in the following Tables:

## Table

### Division 5. Exterior Metal, Ferrous and Non-Ferrous Paint Table

- b. Minimum Dry Film Thickness (DFT): Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 1.5 mil each coat unless specified otherwise in the Tables. Coating thickness where specified, refers to the minimum dry film thickness.
- c. Coatings for Surfaces Not Specified Otherwise: Coat surfaces which have not been specified, the same as surfaces having similar conditions of exposure.
- d. Existing Surfaces Damaged During Performance of the Work, Including New Patches In Existing Surfaces: Coat surfaces with the following:
  - (1) One coat of primer.
  - (2) One coat of undercoat or intermediate coat.
  - (3) One topcoat to match adjacent surfaces.
- e. Existing Coated Surfaces To Be Painted: Apply coatings conforming to the respective specifications listed in the Tables herein, except that pretreatments, sealers and fillers need not be provided on surfaces where existing coatings are soundly adhered and in good condition. Do not omit undercoats or primers.

### 3.5 COATING SYSTEMS FOR METAL

Apply coatings of Tables in Division 5 for Exterior and Interior.

- a. Apply specified ferrous metal primer on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.
- b. Inaccessible Surfaces: Prior to erection, use one coat of specified primer on metal surfaces that will be inaccessible after erection.
- c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.
- d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 1.5 mils DFT immediately prior to application of epoxy or urethane coatings.
- e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.
- f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces. On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

### 3.6 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

### 3.7 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows. Do not use kerosene or any such organic solvents to clean up water based paints. Properly dispose of paints or solvents in designated containers. Close and seal partially used containers of paint to maintain quality as necessary for reuse. Store in protected, well-ventilated, fire-safe area at moderate temperature. Place materials defined as hazardous or toxic waste in designated containers. Coordinate with manufacturer for take-back program. Set aside scrap to be returned to manufacturer for recycling into new product. When such a service is not available, local recyclers shall be sought after to reclaim the materials.

### 3.8 PAINT TABLES

All DFT's are minimum values.

#### 3.8.1 EXTERIOR PAINT TABLES

##### DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

##### STEEL / FERROUS SURFACES

- A. New Steel that has been hand or power tool cleaned to SSPC SP 2 or SSPC SP 3

New; MPI EXT 5.1Q-G6 (Gloss) / Existing; MPI REX 5.1D-G6

Primer: Intermediate: Topcoat:

MPI 23 MPI 9 MPI 9

System DFT: 5.25 mils

- B. New Steel that has been blast-cleaned to SSPC SP 6:

New; MPI EXT 5.1D-G6 (Gloss) / Existing; MPI REX 5.1D-G6

Primer: Intermediate: Topcoat:

MPI 79 MPI 9 MPI 9

System DFT: 5.25 mils

- D. New and existing steel blast cleaned to SSPC SP 10:

MPI EXT 5.1R-G6 (Gloss)

Primer: Intermediate: Topcoat:

MPI 101 MPI 108 MPI 164

System DFT: 8.5 mils

SECTION 26 00 00.00 20

BASIC ELECTRICAL MATERIALS AND METHODS

07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

(b) (7)(E)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

(b) (7)(E)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

(b) (7)(E)

1.2 RELATED REQUIREMENTS

This section applies to certain sections of Division 02, EXISTING CONDITIONS Division 4, EQUIPMENT, Division 13, SPECIAL CONSTRUCTION. This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections. This section has been incorporated into, and thus, does not apply to, and is not referenced in the following sections.

Section 26 23 00 SWITCHBOARDS AND SWITCHGEAR  
Section 26 56 00 EXTERIOR LIGHTING

### 1.3 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in (b) (7)(E).
- b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.
- c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

### 1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be (b) (7)(E) .  
Final connections to the power distribution system to the existing substation shall be made by the Contractor as directed by the Contracting Officer.

### 1.5 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

#### 1.5.1 Shop Drawings (SD-02)

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

#### 1.5.2 Product Data (SD-03)

Submittal shall include performance and characteristic curves.

### 1.6 QUALITY ASSURANCE

#### 1.6.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of (b) (7)(E) unless more stringent requirements are specified or indicated.

#### 1.6.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in

satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

#### 1.6.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

#### 1.6.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

#### 1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

#### 1.8 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

- a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
- b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
- c. Safety precautions.
- d. The procedure in the event of equipment failure.
- e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

#### 1.9 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

#### 1.10 FIELD FABRICATED NAMEPLATES

(b) (7)(E). Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

#### 1.11 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

- a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.
- b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

#### 1.12 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to (b) (7)(E), and requirements specified herein.

#### 1.13 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications.

### PART 2 PRODUCTS

#### 2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements specified in the technical sections.

### PART 3 EXECUTION

#### 3.1 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

#### 3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

#### 3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

-- End of Section --



SECTION 26 05 00.00 40

COMMON WORK RESULTS FOR ELECTRICAL

11/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

(b) (7)(E)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

(b) (7)(E)

INTERNATIONAL CODE COUNCIL (ICC)

(b) (7)(E)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

(b) (7)(E)

(b) (7)(E)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

(b) (7)(E)

UNDERWRITERS LABORATORIES (UL)

(b) (7)(E)

## 1.2 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std's Dictionary.
- b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.
- c. Vertical assembly: A vertical assembly is a pole, tower or other such support, mounting hardware, arms, brackets and the load. Load can be a luminaire, siren, loudspeaker or other device. All

components of a vertical assembly will be rated by the manufacturer to withstand (b) (7)(E)  
(b) (7)(E)

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-01 Preconstruction Submittals

Submit Material, Equipment, and Fixture Lists for the following:

Conduits, Raceway and Fittings

Wire and Cable

Splices and Connectors

Switches

Receptacles

Outlets, Outlet Boxes, and Pull Boxes

Circuit Breakers

Panelboards

Lamps and Lighting Fixtures

Dry-Type Distribution Transformers

#### SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Conduits, Raceway and Fittings

Wire and Cable

Splices and Connectors

Switches

Receptacles

Outlets, Outlet Boxes, and Pull Boxes

Circuit Breakers

Panelboards

Lamps and Lighting Fixtures

Dry-Type Distribution Transformers

Spare Parts

Certification

Submittal for vertical assemblies will be reviewed by a licensed Mechanical, Civil or Structural Engineer to determine that the entire assembly will withstand (b) (7)(E) .

#### SD-o6 Test Reports

Continuity Test

Phase-Rotation Tests

Insulation Resistance Test

#### SD-o8 Manufacturer's Instructions

Submit Manufacturer's Instructions.

### 1.4 PREVENTION OF CORROSION

Protect metallic materials against corrosion. Provide equipment enclosures with the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09 96 00 HIGH-PERFORMANCE COATINGS. Do not use aluminum when in contact with earth or concrete and, where connected to dissimilar metal, protect by approved fittings and treatment. Ferrous metals such as, but not limited to, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous spare parts not of corrosion-resistant steel shall be hot-dip galvanized except where other equivalent protective treatment is specifically approved in writing.

### 1.5 GENERAL REQUIREMENTS

Submit material, equipment, and fixture lists for the following items showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Submit manufacturer's instructions including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

Submit certification required to install equipment components and system packages.

### 1.6 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

- a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

- b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
- c. Safety precautions.
- d. The procedure in the event of equipment failure.
- e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and be secured to prevent easy removal or peeling.

#### 1.7 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

#### 1.8 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

#### 1.9 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

- a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.
- b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products.

#### 2.1.1 Rigid Steel Conduit

Rigid steel conduit shall comply with (b) (7)(E). Rigid steel conduit shall be (b) (7)(E) where underground and in corrosive areas, or must be painted with bitumastic.

(b) (7)(E)

(b) (7)(E), except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Covers shall have (b) (7)(E).

#### 2.1.2 Electrical Metallic Tubing (EMT)

EMT shall be in accordance with (b) (7)(E). Couplings and connectors shall be (b) (7)(E). Crimp, spring, or setscrew type fittings are not acceptable.

#### 2.1.3 Flexible Metallic Conduit

Flexible metallic conduit shall comply with (b) (7)(E).

Fittings for flexible metallic conduit shall be specifically designed for such conduit.

Provide liquidtight flexible metallic conduit (b) (7)(E).

Specifically design fittings for liquidtight flexible metallic conduit for such conduit.

#### 2.1.4 Intermediate Metal Conduit

Intermediate metal conduit shall comply with (b) (7)(E).

#### 2.1.5 Rigid Nonmetallic Conduit

Rigid nonmetallic conduit shall comply with (b) (7)(E).

#### 2.1.6 Wireways and Auxiliary Gutters

Wireway and auxiliary gutters shall be a minimum (b) (7)(E).

#### 2.1.7 Surface Raceways and Assemblies

Surface metal raceways and multi-outlet assemblies shall conform to (b) (7)(E). Receptacles shall conform to (b) (7)(E).

#### 2.1.8 Cable Trays

Provide ladder type cable trays conforming to (b) (7)(E).

## 2.2 WIRE AND CABLE

Conductors installed in conduit shall be (b) (7)(E). All conductors AWG No. 8 and larger, (b) (7)(E). All conductors smaller than AWG No. 8 (b) (7)(E).

Flexible cable shall be (b) (7)(E) and contain (b) (7)(E).

Conductors installed (b) (7)(E).

## 2.3 SPLICES AND CONNECTORS

Make all splices in (b) (7)(E) smaller with approved indentor crimp-type connectors and compression tools.

Make all splices in AWG No. 6 and larger with indentor crimp-type connectors and compression tools. Joints shall be (b) (7)(E).

## 2.4 SWITCHES

### 2.4.1 Safety Switches

Safety switches shall comply with (b) (7)(E) as indicated. Switch construction shall be such that, when (b) (7)(E). Cover release device shall be (b) (7)(E). Make provisions (b) (7)(E).

Provide switches of the (b) (7)(E).

Safety color coding for identification of safety switches shall conform to (b) (7)(E).

### 2.4.2 Toggle Switches

Toggle switches shall comply with (b) (7)(E), control incandescent, mercury, and fluorescent lighting fixtures and be of the heavy duty, general purpose, noninterchangeable flush-type.

Toggle switches shall be commercial grade toggle type, single-pole, three-way two-position devices rated (b) (7)(E).

All toggle switches shall be products of the same manufacturer.

## 2.5 RECEPTACLES

Receptacles shall be commercial grade, (b) (7)(E) conforming to (b) (7)(E).

## 2.6 OUTLETS, OUTLET BOXES, AND PULL BOXES

Outlet boxes for use with conduit systems shall be in accordance with (b) (7)(E) (b) (7)(E) Furnish all pull and junction boxes with screw-fastened covers.

## 2.7 PANELBOARDS

Lighting and appliance branch circuit panelboards shall be the circuit-breaker type in accordance with (b) (7)(E) (b) (7)(E) (b) (7)(E) (b) (7)(E) (b) (7)(E)

## 2.8 CIRCUIT BREAKERS

Circuit-breaker interrupting rating shall be (b) (7)(E) (b) (7)(E) (b) (7)(E)

## 2.9 LAMPS AND LIGHTING FIXTURES

Manufacturers and catalog numbers shown are indicative of the general type desired and are not intended to restrict the selection to fixtures of any particular manufacturer. Fixtures with the same salient features and equivalent light distribution and brightness characteristics, of equal finish and quality, are acceptable. Provide lamps of the proper type and wattage for each fixture.

High intensity discharge (HID) lighting fixtures shall have prewired integral ballasts and cast aluminum housings complete with tempered glass lenses suitable for installation in damp or wet locations. Provide fixtures and lamps.

## 2.10 DRY-TYPE DISTRIBUTION TRANSFORMERS

(b) (7)(E) (b) (7)(E) (b) (7)(E)

# PART 3 EXECUTION

## 3.1 CONDUITS, RACEWAYS AND FITTINGS

Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of (b) (7)(E) (b) (7)(E)

Do not install crushed or deformed conduit. Avoid trapped conduit runs where possible. Take care to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clear any clogged conduit of obstructions or be replaced.

Conduit and raceway runs concealed in or behind walls, above ceilings, or exposed on walls and ceilings (b) (7)(E) above finished floors and not subject to mechanical damage may be (b) (7)(E) (b) (7)(E)



### 3.1.1 Rigid Steel Conduit

Make field-made bends and offsets with approved hickey or conduit bending machine. Conduit elbows larger than (b) (7)(E) shall be long radius.

Provide all conduit stubbed-up through concrete floors for connections to free-standing equipment with the exception of motor-control centers, cubicles, and other such items of equipment, with a flush coupling when the floor slab is of sufficient thickness. Otherwise, provide a floor box set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

### 3.1.2 Electrical Metallic Tubing (EMT)

EMT shall be grounded in accordance with (b) (7)(E) using pressure grounding connectors especially designed for EMT.

### 3.1.3 Flexible Metallic Conduit

Use flexible metallic conduit to connect recessed fixtures from outlet boxes in ceilings, transformers, and other approved assemblies.

(b) (7)(E)

(b) (7)(E)

(b) (7)(E)

### 3.1.4 Intermediate Conduit

Make all field-made bends and offsets with approved hickey or conduit bending machine. Use intermediate metal conduit only for indoor installations.

### 3.1.5 Rigid Nonmetallic Conduit

Rigid PVC conduit shall be (b) (7)(E)

(b) (7)(E)

### 3.1.6 Wireway and Auxiliary Gutter

Straight sections and fittings shall be bolted together to provide a rigid, mechanical connection and electrical continuity. Dead ends of wireways and auxiliary gutters shall be closed. Plug all unused conduit openings.

Wireways for overhead distribution and control circuits shall be supported at (b) (7)(E) intervals.

Auxiliary gutters used to supplement wiring spaces for equipment not contained in a single enclosure shall contain no switches, overcurrent devices, appliances, or apparatus and be not more than (b) (7)(E) long.

### 3.1.7 Surface Raceways and Assemblies

Surface raceways shall be mounted plumb and level, with the base and cover secured. Minimum circuit run shall be (b) (7)(E).

### 3.2 WIRING

Feeder and branch circuit conductors shall be color coded as follows:

<u>CONDUCTOR</u>	<u>COLOR AC</u>
------------------	-----------------

(b) (7)(E)	
------------	--

Conductors up to and including AWG No. 2 shall be manufactured with (b) (7)(E).  
Conductors larger than AWG No. 2 shall have (b) (7)(E).

Splice in accordance with the (b) (7)(E). Provide conductor identification within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Terminal and conductor identification shall match as indicated.

Where several feeders pass through a common pullbox, the feeders shall be tagged to clearly indicate the electrical characteristics, circuit number, and panel designation.

### 3.3 SAFETY SWITCHES

Securely fasten switches to the supporting structure or wall, utilizing a minimum of (b) (7)(E). Do not use sheet metal screws and small machine screws for mounting. Do not mount switches in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height shall be (b) (7)(E) when possible.

### 3.4 WIRING DEVICES

#### 3.4.1 Wall Switches and Receptacles

Install wall switches and receptacles so that when device plates are applied, the plates will be aligned vertically (b) (7)(E).

Ground terminal of each flush-mounted receptacle shall be bonded to the outlet box with an approved green bonding jumper when used with dry wall type construction.

#### 3.4.2 Device Plates

Device plates for switches that are not within sight of the loads controlled shall be suitably engraved with a description of the loads.

Device plates and receptacle cover plates for receptacles other than (b) (7)(E) Required marking shall consist of a self-adhesive label having 1/4 inch embossed letters.

Device plates for convenience outlets shall be similarly marked indicating the supply panel and circuit number.

### 3.5 BOXES AND FITTINGS

Furnish and install pullboxes where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than (b) (7)(E).

Securely mount boxes and enclosures to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Mounting height of wall-mounted outlet and switch boxes, measured between the bottom of the box and the finished floor, shall be in accordance with (b) (7)(E) and as follows:

<u>LOCATION</u>	<u>MOUNTING HEIGHT</u>
Receptacles in offices	(b) (7)(E)
Receptacles in corridors	(b) (7)(E)
Receptacles in shops and laboratories	(b) (7)(E)
Receptacles in rest rooms	(b) (7)(E)
Switches for light control	(b) (7)(E)

### 3.6 LAMPS AND LIGHTING FIXTURES

Install new lamps of the proper type and wattage in each (b) (7)(E) (b) (7)(E)

### 3.7 PANELBOARDS

Securely mount panelboards so that the top operating handle does not exceed (b) (7)(E) above the finished floor. Do not mount equipment within (b) (7)(E) of the front of the panel. Directory card information shall be complete and legible.

### 3.8 DRY-TYPE DISTRIBUTION TRANSFORMERS

(b) (7)(E)

(b) (7)(E)  
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT.

### 3.9 IDENTIFICATION PLATES AND WARNINGS

Furnish and install identification plates for lighting and power panelboards, motor control centers, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, door bells, pilot lights, disconnect switches, manual starting switches, and magnetic starters. Process control devices and pilot lights shall have identification plates.

Furnish identification plates for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase(s) and power source. Circuits 480 volts and above shall have conspicuously located warning signs in accordance with OSHA requirements.

### 3.10 PAINTING

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks shall be thoroughly cleaned and painted as specified in Section 09 90 00 PAINTS AND COATINGS or Section 09 96 00 HIGH-PERFORMANCE COATINGS.

### 3.11 FIELD TESTING

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

Submit Test Reports in accordance with referenced standards in this section.

After completion of the installation and splicing, and prior to energizing the conductors, perform wire and cable continuity and insulation tests as herein specified before the conductors are energized.

Contractor shall provide all necessary test equipment, labor, and personnel to perform the tests, as herein specified.

Isolate completely all wire and cable from all extraneous electrical connections at cable terminations and joints. Substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices shall be used to isolate the circuits under test.

Perform insulation-resistance test on each field-installed conductor with respect to ground and adjacent conductors. Applied potential shall be (b) (7)(E)

Take readings after 1 minute and until the reading is constant for 15 seconds. Minimum insulation-resistance values shall not be less than (b) (7)(E)

For circuits with conductor sizes 8AWG and smaller insulation resistance testing is not required.

Perform continuity test to insure correct cable connection (i.e correct phase conductor, grounded conductor, and grounding conductor wiring) end-to end. Any damages to existing or new electrical equipment resulting from contractor mis-wiring will be repaired and re-verified at contractor's expense. All repairs shall be approved by the CO prior to acceptance of the repair.

Conduct phase-rotation tests on all three-phase circuits using a phase-rotation indicating instrument. Perform phase rotation of electrical connections to connected equipment clockwise, facing the source.

Final acceptance will depend upon the successful performance of wire and cable under test. Do not energize any conductor until the final test reports are reviewed and approved by the CO.

-- End of Section --

SECTION 26 05 19.00 10

INSULATED WIRE AND CABLE  
11/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

(b) (7)(E)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

(b) (7)(E)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

(b) (7)(E)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Installation Instructions

Cable manufacturing data as requested.

SD-06 Test Reports

Tests, Inspections, and Verifications

Two certified copies of test reports.

1.3 DELIVERY, STORAGE, AND HANDLING

Furnish cables on reels or coils. Each cable and the outside of each reel or coil, shall be plainly marked or tagged to indicate the cable length, voltage rating, conductor size, and manufacturer's lot number and reel number. Each coil or reel of cable shall contain only one continuous cable without splices. Cables for exclusively dc applications, as specified in paragraph HIGH VOLTAGE TEST SOURCE, shall be identified as such. Shielded cables rated (b) (7)(E) volts and above shall be reeled and marked in accordance with Section (b) (7)(E), as applicable. Reels shall remain the property of the Government.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Wire Table

Furnish wire and cable in accordance with the requirements of the wire table below, conforming to the detailed requirements specified herein.

#### 2.1.2 Rated Circuit Voltages

All wire and cable shall have minimum rated circuit voltages in accordance with (b) (7)(E).

#### 2.1.3 Conductors

##### 2.1.3.1 Material for Conductors

Conductors shall conform to all the applicable requirements of (b) (7)(E), as applicable, and shall be (b) (7)(E). (b) (7)(E) conductors may be (b) (7)(E), if required by the type of insulation used.

##### 2.1.3.2 Size

Minimum wire size shall be (b) (7)(E) for power and lighting circuits; (b) (7)(E) for current transformer secondary circuits; (b) (7)(E) for potential transformer, relaying, and control circuits; No. (b) (7)(E) for annunciator circuits; and (b) (7)(E) for alarm circuits. Minimum wire sizes for rated circuit voltages of (b) (7)(E) shall not be less than those listed for the applicable voltage in (b) (7)(E), as applicable.

##### 2.1.3.3 Stranding

Conductor stranding classes cited herein shall be as defined in (b) (7)(E), as applicable. Lighting conductors No. 10 AWG and smaller shall be (b) (7)(E). Any conductors used between stationary and moving devices, such as hinged doors or panels, shall have (b) (7)(E). (b) (7)(E) All other conductors shall have (b) (7)(E) g, except that conductors shown on the drawings, or in the schedule, as No. 12 AWG (b) (7)(E) and conductors shown as No. 10 AWG may be (b) (7)(E).

##### 2.1.3.4 Conductor Shielding

Use conductor shielding conforming to (b) (7)(E) as applicable, on power cables having a rated circuit voltage above (b) (7)(E). In addition, conductor shielding for shielded cables shall also comply with (b) (7)(E). Strict precautions shall be taken after application of the conductor shielding to prevent the inclusion of voids or contamination between the conductor shielding and the subsequently applied insulation.

#### 2.1.3.5 Separator Tape

Where conductor shielding, strand filling, or other special conductor treatment is not required, a separator tape between conductor and insulation is permitted.

#### 2.1.4 Insulation

##### 2.1.4.1 Insulation Material

Provide insulation which is a (b) (7)(E) type, meeting the requirements of (b) (7)(E), as applicable, or an (b) (7)(E) type meeting the requirements of (b) (7)(E). For shielded cables of rated circuit voltages above (b) (7)(E), the following provisions shall also apply:

- a. (b) (7)(E).
- b. (b) (7)(E).
- c. The insulation material and its manufacturing, handling, extrusion and vulcanizing processes, shall all be subject to strict procedures to prevent the inclusion of voids, contamination, or other irregularities on or in the insulation. Insulation material shall be inspected for voids and contaminants. Inspection methods, and maximum allowable void and contaminant content shall be in accordance with Section (b) (7)(E), as applicable.
- d. Cables with repaired insulation defects discovered during factory testing, or with splices or insulation joints, are not acceptable unless specifically approved.

##### 2.1.4.2 Insulation Thickness

The insulation thickness for each conductor shall be based on its rated circuit voltage.

- a. Power Cables/Single-Conductor Control (b) (7)(E) - The insulation thickness for single-conductor cables rated (b) (7)(E) shall be as required by (b) (7)(E) as applicable. (b) (7)(E)
- b. Power Cables, Rated (b) (7)(E) - Thickness of insulation for power cables rated (b) (7)(E) shall be in accordance with the following:
  - (1) Non-shielded cables, (b) (7)(E) as applicable.
  - (2) Shielded cables (b) (7)(E) as applicable.
- c. Multiple-Conductor Control Cables - The insulation thickness of multiple-conductor cables used for control and related purposes shall be as required by (b) (7)(E) as applicable.

##### 2.1.4.3 Insulation Shielding

Unless otherwise specified, provide insulation shielding for conductors having rated circuit voltages of (b) (7)(E). The voltage limits above which insulation shielding is required, and the material

requirements, are given in (b) (7)(E), as applicable. The material, if (b) (7)(E), as applicable. The method of shielding shall be in accordance with the current practice of the industry; however, the application process shall include strict precautions to prevent voids or contamination between the insulation and the nonmetallic component. Voids, protrusions, and indentations of the shield shall not exceed the maximum allowances specified in (b) (7)(E), as applicable. The cable shall be capable of operating without damage or excessive temperature when the shield is grounded at both ends of each conductor. All components of the shielding system shall remain tightly applied to the components they enclose after handling and installation in accordance with the manufacturer's recommendations. Shielding systems which require heat to remove will not be permitted unless specifically approved.

#### 2.1.5 Jackets

All cables shall have jackets meeting the requirements of (b) (7)(E), as applicable, and as specified herein. Individual conductors of multiple-conductor cables shall be required to have jackets only if they are necessary for the conductor to meet other specifications herein. Jackets of single-conductor cables and of individual conductors of multiple-conductor cables, except for shielded cables, shall be in direct contact and adhere or be vulcanized to the conductor insulation. Multiple-conductor cables and shielded single-conductor cables shall be provided with a common overall jacket, which shall be tightly and concentrically formed around the core. Repaired jacket defects found and corrected during manufacturing are permitted if the cable, including jacket, afterward fully meets these specifications and the requirements of the applicable standards.

##### 2.1.5.1 Jacket Material

The jacket shall be one of the materials listed below. Variations from the materials required below will be permitted only if approved for each specific use, upon submittal of sufficient data to prove that they exceed all specified requirements for the particular application.

###### a. General Use

(b) (7)(E)

(b) (7)(E)

(b) (7)(E)

b. Accessible Use (b) (7)(E) - Cables installed where they are entirely accessible, such as cable trays and raceways with removable covers, or where they pass through (b) (7)(E), shall have jackets of one of the materials specified in above paragraph GENERAL USE, or the jackets may be of one of the following:

(b) (7)(E)

(b) (7)(E)

(b) (7)(E)

##### 2.1.5.2 Jacket Thickness

The minimum thickness of the jackets at any point shall be not less than (b) (7)(E) of the respective nominal thicknesses specified below.



a. Multiple-Conductor Cables - Thickness of the jackets of the individual conductors of multiple-conductor cables shall be as required by (b) (7)(E)

b. Single-Conductor Cables - Single-conductor cables (b) (7)(E)

#### 2.1.6 Metal-Clad Cable

##### 2.1.6.1 General

The metallic covering shall be corrugated metal, conforming to the applicable requirements of (b) (7)(E). (b) (7)(E). Assembly and cabling shall be as specified in paragraph CABLING. (b) (7)(E)

##### 2.1.6.2 Jackets

Metal-clad cables (b) (7)(E)

#### 2.2 CABLE IDENTIFICATION

##### 2.2.1 Color-Coding

Insulation of individual conductors of multiple-conductor cables shall be color-coded in accordance with (b) (7)(E), except that colored braids will not be permitted. Only one color-code method shall be used for each cable construction type. Control cable color-coding shall be in accordance with (b) (7)(E). Power cable color-coding shall be (b) (7)(E), if included.

##### 2.2.2 Shielded Cables Rated (b) (7)(E)

Marking shall be in accordance with (b) (7)(E) as applicable.

##### 2.2.3 Cabling

Individual conductors of multiple-conductor cables shall be assembled with (b) (7)(E). Fillers shall be (b) (7)(E)

#### 2.2.4 Dimensional Tolerance

The outside diameters of single-conductor cables and of multiple-conductor cables shall not vary more than (b) (7)(E), respectively, from the manufacturer's published catalog data.

### PART 3 EXECUTION

#### 3.1 INSTALLATION INSTRUCTIONS

The following information shall be provided by the cable manufacturer for each size, conductor quantity, and type of cable furnished:

- a. Minimum bending radius, in inches - For multiple-conductor cables, this information shall be provided for both the individual conductors and the multiple-conductor cable.
- b. Pulling tension and sidewall pressure limits, in pounds.
- c. Instructions for stripping semiconducting insulation shields, if furnished, with minimum effort without damaging the insulation.
- d. Upon request, compatibility of cable materials and construction with specific materials and hardware manufactured by others shall be stated. Also, if requested, recommendations shall be provided for various cable operations, including installing, splicing, terminating, etc.

#### 3.2 TESTS, INSPECTIONS, AND VERIFICATIONS

##### 3.2.1 Cable Data

Manufacture of the wire and cable shall not be started until all materials to be used in the fabrication of the finished wire or cable have been approved by the Contracting Officer. Cable data shall be submitted for approval including dimensioned sketches showing cable construction, and sufficient additional data to show that these specifications will be satisfied.

##### 3.2.2 Inspection and Tests

Inspection and tests of wire and cable furnished under these specifications shall be made by and at the plant of the manufacturer, and shall be witnessed by the Contracting Officer or his authorized representative, unless waived in writing. The Government may perform further tests before or after installation. Testing in general shall comply with (b) (7)(E). Specific tests required for particular materials, components, and completed cables shall be as specified in the sections of the above standards applicable to those materials, components, and cable types. Tests shall also be performed in accordance with the additional requirements specified below.

##### 3.2.2.1 High-Voltage Test Source

Where the applicable standards allow a choice, high-voltage tests for cables to be used exclusively on dc circuits shall be made with dc test voltages. Cables to be used exclusively on ac circuits shall be tested with ac test voltages. If both ac and dc will be present, on either the same or separate conductors of the cable, ac test voltages shall be used.

##### 3.2.2.2 Shielded Cables Rated (b) (7)(E) or Greater

The following tests shall be performed in addition to those specified above. Section or paragraph references are to (b) (7)(E) as applicable, unless otherwise stated.

- a. High potential test voltages shall be as required by Table (b) (7)(E) as applicable, rather than by (b) (7)(E).
- b. If high potential testing is done with an ac test voltage as specified in paragraph HIGH-VOLTAGE TEST SOURCE, an additional test shall be made using a dc test voltage rated at (b) (7)(E).
- c. Production sampling tests shall be performed in accordance with Section D. Sampling frequency and failure contingencies shall be in accordance with paragraph G.3. Unless otherwise approved, samples shall not be taken from the middle of extruder runs of insulation or shielding made only for one continuous shipping length of cable, if such sampling will result in the need to repair the sampled area.
- d. Partial discharge tests shall be performed in accordance with Section E, paragraph E.2, and Section F.

#### 3.2.2.3 Flame Tests

All multiple-conductor and single-conductor cable assemblies shall pass (b) (7)(E) flame tests, (b) (7)(E). Single-conductor cables and individual conductors of multiple-conductor cables shall pass the flame test of (b) (7)(E). If such tests, however, have previously been made on identical cables, these tests need not be repeated. Instead, certified reports of the original qualifying tests shall be submitted. In this case the reports furnished under paragraph REPORTS, shall verify that all of each cable's materials, construction, and dimensions are the same as those in the qualifying tests.

#### 3.2.2.4 Independent Tests

The Government may at any time make visual inspections, continuity or resistance checks, insulation resistance readings, power factor tests, or dc high-potential tests at field test values. A cable's failure to pass these tests and inspections, or failure to produce readings consistent with acceptable values for the application, will be grounds for rejection of the cable.

#### 3.2.2.5 Reports

Furnish results of tests made. No wire or cable shall be shipped until authorized. Lot number and reel or coil number of wire and cable tested shall be indicated on the test reports.



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LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

(b) (7)(E)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

(b) (7)(E)

(b) (7)(E)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

(b) (7)(E)

UNDERWRITERS LABORATORIES (UL)

(b) (7)(E)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-01 Preconstruction Submittals

Prior to the beginning of construction, submit manufactures equipment and performance data for the following items including use life, system functional flows, safety features, and mechanical automated details..

Fuses

### SD-02 Shop Drawings

Submit Connection Diagrams and Fabrication Drawings for the following items in accordance with paragraph entitled, "General Requirements," of this section.

Submit Installation drawings for the following items in accordance with the paragraph entitled, "Installation," of this section.

Control Devices  
Protective Devices

### SD-03 Product Data

Submit manufacturer's equipment and performance data for the following items including use life, system functional flows, safety features, and mechanical automated details.

### Motor Control

Instrument Transformers  
Enclosures  
Circuit Breakers  
Control Devices  
Time Switches  
Protective Relays

Indicating Instruments  
Indicating Lights

#### SD-07 Certificates

Submit certificates for Circuit Tests on similar motor-control or submit motor-circuit protector (MCP) units under actual conditions in lieu of factory tests on the actual units provided. Also include dielectric tests.

#### SD-08 Manufacturer's Instructions

Submit manufacturer's instructions for the following items, including special provisions required to install equipment components and system packages. Provide detail on resistance impedances, hazards and safety precautions within the special notices.

Control Devices  
Protective Devices

#### SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals for the following equipment:

Manual Motor Controllers  
Magnetic Motor Controllers  
Combination Motor Controllers  
Circuit Breakers  
Time Switches  
Protective Relays  
Indicating Instruments

### 1.3 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Submit Connection Diagrams showing the relations and connections of control devices and protective devices by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Submit Fabrication Drawings for control devices and protective devices consisting of fabrication and assembly details to be performed in the factory.

## PART 2 PRODUCTS

### 2.1 MOTOR CONTROL

Conform to (b) (7)(E) for motor controllers. Provide controllers that have thermal overload protection in each phase.

#### 2.1.1 Manual Motor Controllers

Provide full-voltage, manually operated manual motor controllers for the control and protection of single-phase (b) (7)(E) motors.

Provide (b) (7)(E) (b) (7)(E) Include a supporting base or body of electrical insulating material with enclosed switching mechanism, yoke, thermal overload relay, and terminal connectors. Provide controllers that clearly indicate operating condition: on, off, or tripped.

Provide (b) (7)(E) (b) (7)(E) .

Provide (b) (7)(E) (b) (7)(E) motors, that include (b) (7)(E) (b) (7)(E) (b) (7)(E) (b) (7)(E) (b) (7)(E) .

Provide (b) (7)(E) (b) (7)(E) (b) (7)(E) (b) (7)(E) (b) (7)(E) .

## 2.1.2 Magnetic Motor Controllers

### 2.1.2.1 Full-Voltage Controllers

Provide full-voltage, full magnetic devices in accordance with (b) (7)(E) and (b) (7)(E) for magnetic motor controllers for the control and protection of (b) (7)(E) (b) (7)(E) .

Provide operating coil assembly that operates satisfactorily between (b) (7)(E) of rated coil voltage. Provide (b) (7)(E) .

Provide controller with (b) (7)(E) rated per (b) (7)(E) (b) (7)(E) in addition to (b) (7)(E) .

Provide (b) (7)(E) (b) (7)(E) s to controllers.

Include (b) (7)(E) (b) (7)(E) (b) (7)(E) , and with a (b) (7)(E) adjustment to compensate for (b) (7)(E) (b) (7)(E) .

Provide an (b) (7)(E) (b) (7)(E) (b) (7)(E) .

Provide enclosure in accordance with (b) (7)(E) .



#### 2.1.2.2 Reduced-Voltage Starters

Conform to the requirements for full-voltage controllers for reduced-voltage starters, except for voltage, and to the following additional requirements.

Fully protect the motor during all phases of motor starting with an overload device in each motor leg. Rate starter contacts to (b) (7)(E). Provide starter that contains (b) (7)(E).

Adequately ventilate resistors and autotransformers used for starting. (b) (7)(E)

For solid-state starters, provide (b) (7)(E)

#### 2.1.3 Combination Motor Controllers

Following requirements are in addition to the requirements specified for magnetic motor controller:

Provide combination motor controllers for the control and protection of (b) (7)(E) with (b) (7)(E) in accordance with (b) (7)(E).

For combination motor controllers include (b) (7)(E)

as follows:

Provide full-voltage, full-magnetic devices as specified in this section under paragraph entitled, "Remote-Control Station Enclosures." for magnetic motor controllers and enclosures.

Provide thermal-magnetic breakers as specified in paragraph entitled, "Manual Motor Controllers." for molded-case circuit breakers. Manufacturer's standard MCP may be used in lieu of molded-case circuit breakers.

Provide control-power transformers (b) (7)(E), selector switches, pushbuttons, and pilot lights as required.

Identify combination motor controllers with identification plates affixed to front cover of the controller.

##### 2.1.3.1 Nonreversing Combination Motor Controllers

Following requirements are in addition to the requirements for magnetic motor controllers:

(b) (7)(E)

Provide rating of (b) (7)(E) magnetic controllers for (b) (7)(E) in accordance with (b) (7)(E).

Provide wiring and connections for (b) (7)(E) magnetic controllers in accordance with (b) (7)(E).

#### 2.1.3.2 Reversing Combination Motor Controllers

Following requirements are in addition to the requirements for magnetic motor controllers:

For reversing combination motor controllers for the control and protection of (b) (7)(E) include (b) (7)(E)

Provide rating of (b) (7)(E) magnetic controllers for (b) (7)(E) in accordance with (b) (7)(E)

Provide wiring and connections for (b) (7)(E) magnetic controllers in accordance with (b) (7)(E).

#### 2.1.3.3 Two-Speed Combination Motor Controllers

Following requirements are in addition to the requirements for magnetic motor controllers:

For two-speed combination motor controllers for the control and protection of (b) (7)(E) induction motors, include (b) (7)(E)

Provide rating of (b) (7)(E), (b) (7)(E) in accordance with (b) (7)(E)

Provide rating of (b) (7)(E), (b) (7)(E) in accordance with (b) (7)(E) 2.

Provide rating of (b) (7)(E), (b) (7)(E) motors in accordance with (b) (7)(E).

#### 2.2 INSTRUMENT TRANSFORMERS

Comply with the interference requirements listed below, measured in accordance with (b) (7)(E) for Instrument transformers.

Preferred	Radio Influence
Basic Nominal Test Voltage	Test Voltage Voltage Level,
Insulation Insulation System	for Potential for Current <u>Microvolts</u>
Class, Level, Voltage, Transformers,	Dry Oil

kV    kV    kV    kV    kV    Type   Filled

---

(b) (7)(E)

#### 2.2.1 Current Transformers

Provide current transformers that conform to (b) (7)(E) for installation in metal-clad switchgear. Use (b) (7)(E).

Provide (b) (7)(E).

Provide transformers that have (b) (7)(E).

Provide transformers that are (b) (7)(E).

For window-type current transformers, provide (b) (7)(E).

#### 2.2.2 Potential Transformers

For potential transformers, conform to (b) (7)(E) for installation in metal-clad switchgear. Use (b) (7)(E).

Provide transformers that have (b) (7)(E)

Provide burden, frequency, and accuracy as required.

For (b) (7)(E) as required.

## 2.3 ENCLOSURES

### 2.3.1 Equipment Enclosures

Provide enclosures for equipment in accordance with (b) (7)(E).

Contain equipment installed inside, clean, dry locations in a (b) (7)(E), general-purpose sheet-steel enclosure.

Contain equipment installed in wet locations in a (b) (7)(E) watertight, corrosion-resistant sheet-steel enclosure, constructed to prevent entrance of water when tested in accordance with (b) (7)(E) for (b) (7)(E) (b) (7)(E).

Contain equipment installed in industrial locations in a (b) (7)(E) industrial use, sheet-steel enclosure, constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Contain equipment installed in Class I, Division I, Group A, B, C, and D, hazardous locations, in (b) (7)(E) enclosures approved for the specific flammable gas or vapor that is possibly present under normal operating conditions.

Contain equipment installed in Class II, Division I, Group E, F and G, hazardous locations, in (b) (7)(E) enclosures approved for use where combustible dust is possibly present under normal operating conditions.

Fabricate sheet-steel enclosures from uncoated carbon-steel sheets of commercial quality, with box dimensions and thickness of sheet steel in accordance with (b) (7)(E).

Fabricate steel enclosures from corrosion-resistant, chromium-nickel steel sheet conforming to (b) (7)(E) general-purpose polished finish, with box dimensions and thickness of sheet steel in accordance with (b) (7)(E).

Provide cast-iron enclosures from gray-iron castings conforming to (b) (7)(E) with tensile-strength classification recognized as suitable for the application. Provide cast metal enclosures that are not less than (b) (7)(E) at every point, of greater thickness at reinforcing ribs and door edges, and not less than (b) (7)(E) at tapped holes for conduits.

### 2.3.2 Remote-Control Station Enclosures

Provide remote-control station enclosures for pushbuttons, selector switches, and indicating lights in accordance with the appropriate articles of (b) (7)(E).

Contain remote-control stations installed in indoor, clean, dry locations in (b) (7)(E) general-purpose, sheet-steel enclosures. Contain recessed remote-control stations in standard wall outlet boxes with matching corrosion-resistant steel flush cover plate.

Contain remote-control stations installed in wet locations in (b) (7)(E) watertight, corrosion-resistant sheet-steel enclosures constructed to prevent entrance of water when tested in accordance with (b) (7)(E) enclosures.

Contain remote-control stations installed in wet locations in (b) (7)(E) watertight, cast-iron enclosures, constructed to prevent entrance of water when tested in accordance with (b) (7)(E) enclosures.

Contain remote-control stations installed in dry noncombustible dust-laden atmospheres in (b) (7)(E) dusttight, cast-iron enclosures with gaskets or their equivalent to prevent the entrance of dust.

Contain remote-control stations installed in industrial locations in (b) (7)(E) industrial-use, sheet-steel enclosures, constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Contain remote-control stations installed in industrial locations in (b) (7)(E) industrial-use, cast-iron enclosures, constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Contain remote-control stations installed in Class I, Division I, Group A, B, C, and D, hazardous locations in (b) (7)(E) enclosures, approved for the specific flammable gas or vapor which is possibly present under normal operating conditions.

Contain remote-control stations installed in Class II, Division I, Group E, F and G, hazardous locations in (b) (7)(E) enclosures, approved for use where combustible dust is possibly present under normal operating conditions.

Fabricate sheet-steel enclosures from uncoated carbon-steel sheets of commercial quality, with box dimensions and thickness of sheet steel in accordance with (b) (7)(E).

Fabricate steel enclosures from corrosion-resistant, chromium-nickel steel sheet, conforming to (b) (7)(E) general-purpose polished finish, with box dimensions and thickness of sheet steel in accordance with (b) (7)(E).

Provide cast-iron enclosures of gray-iron castings, conforming to (b) (7)(E), with tensile-strength classification recognized as suitable for this application. Provide cast metal enclosures that are (b) (7)(E) at every point, of greater thickness at reinforcing ribs and door edges (b) (7)(E).

Install remote-control stations with the centerline (b) (7)(E) above the finished floor.

## 2.4 CIRCUIT BREAKERS

Provide circuit breakers that conform to (b) (7)(E).

### 2.4.1 Molded-Case Circuit Breakers

Provide molded case, (b) (7)(E), circuit breakers, (b) (7)(E) as required. Completely enclose circuit breakers in a molded case, (b) (7)(E).

Locate thermal-magnetic tripping elements in each pole of the circuit breaker, and provide (b) (7)(E). Provide

(b) (7)(E), that is adjustable (b) (7)(E)  
(b) (7)(E).

Size breaker as required for the continuous current rating of the circuit. Provide breaker class as required.

Provide sufficient interrupting capacity of the panel and lighting branch circuit breakers, (b) (7)(E). Provide circuit breaker interrupting capacities with a minimum of (b) (7)(E) and that conform to (b) (7)(E).

Provide the common-trip type multipole circuit breakers having a (b) (7)(E). Provide circuit breakers with (b) (7)(E) for operation in an ambient temperature of (b) (7)(E). Provide circuit breakers that have (b) (7)(E) to protect the circuit being supplied. Interrupting ratings may have (b) (7)(E).

Provide (b) (7)(E) capable of having such accessories as (b) (7)(E)s attached where required.

Provide circuit breakers used for meter circuit disconnects that meet the applicable requirements of (b) (7)(E) and that are of the motor-circuit protector type.

For circuit breakers used for service disconnection, provide an enclosed circuit-breaker type with external handle for manual operation. Provide sheet metal enclosures with a hinged cover suitable for surface mounting.

#### 2.4.2 Enclosed Molded-Case Circuit Breakers

For enclosed circuit breakers, provide thermal-magnetic molded-case circuit breakers in surface-mounted, nonventilated enclosures conforming to the appropriate articles of (b) (7)(E).

Provide enclosed circuit breakers in nonhazardous locations as follows:

Contain circuit breakers installed inside clean, dry locations in (b) (7)(E), general purpose sheet steel enclosures.

Contain circuit breakers installed in unprotected outdoor locations, in (b) (7)(E) weather-resistant sheet steel enclosures that are splashproof, weatherproof, sleetproof, and moisture resistant.

Contain circuit breakers installed in wet locations, in (b) (7)(E), watertight corrosion-resistant sheet steel enclosures constructed to prevent entrance of water.

Contain circuit breakers installed in wet locations in (b) (7)(E), watertight cast-iron enclosures, constructed to prevent entrance of water when tested in accordance with (b) (7)(E) enclosures.

Contain circuit breakers installed in dry, noncombustible dust-laden atmospheres in (b) (7)(E) dusttight corrosion-resistant sheet steel enclosures, with gaskets or their equivalent to prevent the entrance of dust.

Contain circuit breakers installed in dry, noncombustible, dust-laden atmospheres in (b) (7)(E) dusttight cast-iron enclosures, with gaskets or their equivalent to prevent the entrance of dust.

Contain circuit breakers installed in industrial locations in (b) (7)(E), industrial-use sheet steel enclosures, constructed to prevent the entrance of dust, lint, fibers and flyings, and oil and coolant seepage.

Fabricate steel enclosures from corrosion-resistant steel sheet, conforming to (b) (7)(E) series corrosion-resistant steel, with box dimensions and thickness of sheet steel in accordance with (b) (7)(E).

Provide cast-iron enclosures of gray-iron castings conforming to (b) (7)(E) with tensile strength classification suitable for this application. Provide cast metal enclosures that are (b) (7)(E) (b) (7)(E) at every point, of greater thickness at reinforcing ribs and door edges, and (b) (7)(E) (b) (7)(E).

## 2.5 FUSES

Provide a complete set of fuses for all switches and switchgear. Rate fuses that have a voltage rating of not less than the circuit voltage.

Make no change in continuous-current rating, interrupting rating, and clearing or melting time of fuses unless written permission has first been secured.

Provide (b) (7)(E) type fuses for ratings (b) (7)(E) or less. Provide (b) (7)(E) type fuses for ratings above (b) (7)(E) or less with (b) (7)(E), except where otherwise indicated. Conform to (b) (7)(E) for fuses.

Install special fuses such as (b) (7)(E) where required. (b) (7)(E) are not permitted.

Label fuses showing UL class, interrupting rating, and time-delay characteristics, when applicable. Additionally, clearly list fuse information on equipment drawings.

Provide (b) (7)(E) fuse holders when field-mounted in a cabinet or box. Do not use fuse holders made of such materials as (b) (7)(E) for field installation.

## 2.6 FACTORY TESTING

Perform factory tests on control and low voltage protective devices in accordance with the manufacturer's recommendations.

Conduct short-circuit tests in accordance with Section 2 of (b) (7)(E).

## 2.7 INDICATING LIGHTS

### 2.7.1 General-Purpose Type

For indicating lights, provide oiltight instrument devices with threaded base and collar for flush-mounting, translucent convex lens, candelabra screw-base lampholder, and (b) (7)(E) incandescent lamp in accordance with (b) (7)(E). Provide indicating lights color coded in accordance with (b) (7)(E).

Provide indicating lights in remote-control stations when pushbuttons and selector switches are out of sight of the controller.

#### 2.7.2 Switchboard Indicating Lights

For switchboard indicating lights, provide the manufacturer's standard transformer type units (b) (7)(E) input utilizing low-voltage lamps and convex lenses of the colors indicated. Provide indicating lights that are capable of being (b) (7)(E). Indicating lights utilizing resistors in series with the lamps are not permitted except in direct-current control circuits. Provide lights that have a (b) (7)(E) feature.

#### 2.8 FINISH

Protect metallic materials against corrosion. Provide equipment with the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09 96 00 HIGH-PERFORMANCE COATINGS.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Install Control devices and protective devices that are not factory installed in equipment, in accordance with the manufacturer's recommendations and field adjusted and operation tested. Conform to (b) (7)(E) requirements for installation of control and protective devices.

#### 3.2 FIELD TESTING

Demonstrate to operate as indicated control and protective devices not factory installed in equipment.

-- End of Section --



SECTION 26 09 23.00 40

LIGHTING CONTROL DEVICES

08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

(b) (7)(E)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

(b) (7)(E)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

(b) (7)(E)

UNDERWRITERS LABORATORIES (UL)

(b) (7)(E)

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Submit Installation Drawings for light-sensitive control devices in accordance with the manufacturer's recommended instructions for installation.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-03 Product Data

Submit manufacturer's catalog data for Photoconductive Control Devices.

Submit Installation Drawings for Light-Sensitive Control Devices in accordance with paragraph entitled, "General Requirements," of this section.

Lighting Contactor; G

Time Switch; G

Photocell Switch; G

#### SD-06 Test Reports

Submit test reports for System Operation Tests in the presence of the Contracting Officer.

#### SD-08 Manufacturer's Instructions

Submit operational instructions for Light-Sensitive Control Devices consisting of the manufacturer's recommended procedures for operation.

#### SD-10 Operation and Maintenance Data

Lighting Control System, Data Package 5; G

### 1.4 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

## PART 2 PRODUCTS

### 2.1 PHOTOCONDUCTIVE CONTROL DEVICES

Provide photoconductive control devices in accordance with (b) (7)(E). Control lighting luminaires in banks by a (b) (7)(E). Provide physically and electrically interchangeable light sensitive control devices with (b) (7)(E)

Provide photoconductive control devices for natural daylight and darkness control of incandescent, fluorescent, and outdoor lighting luminaires including a (b) (7)(E). Provide a control device which is, when attached to its mounting, weatherproof and constructed to exclude beating rain, snow, dust, and insects and capable of withstanding (b) (7)(E) under operating conditions.

Submit operation and maintenance data, Lighting Control System, Data Package 5, in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein, showing all light fixtures, control modules, control zones, occupancy sensors (b) (7)(E), light level sensors, power packs, dimming ballasts, schematic diagrams and all interconnecting control wire, conduit, and associated hardware.

#### 2.1.1 Photoconductive Limit Settings

Provide device which turns on within the limits of (b) (7)(E) of its setting, over a range of input voltage from (b) (7)(E) s at rated frequency and ambient temperature, and at rated voltage and frequency over a range of temperature from (b) (7)(E), with relative humidities up to (b) (7)(E) t throughout the temperature range.

Adjust the device to operate within the limits of (b) (7)(E), but also capable of calibration of the turn-on light level over a minimum range from (b) (7)(E), and adaptable for calibration up to (b) (7)(E). Ratio of turn-off light level to turn-on light level is (b) (7)(E).

#### 2.1.2 Device Rating and Accuracy

Rate the devices at (b) (7)(E), with rated ambient temperature of (b) (7)(E) degrees F.

Maintain instrument accuracy by proper calibration in accordance with (b) (7)(E).

#### 2.2 TIME CONTROL SWITCHES

Install switches with not less than (b) (7)(E). The use of (b) (7)(E) is not allowed.

#### 2.3 MANUAL AND SAFETY SWITCHES

Provide (b) (7)(E). Provide a switch rated (b) (7)(E). Provide surface mounted housing for the time switch, type (b) (7)(E) (outdoor) enclosure conforming to (b) (7)(E).

Provide switch mechanism consisting of (b) (7)(E). Provide with a (b) (7)(E). Use the (b) (7)(E) control is desired. Interface (b) (7)(E).

Provide switches conforming to (b) (7)(E). Provide switch construction of the (b) (7)(E). Coordinate terminal lugs with the wire size.

## 2.4 DIMMING BALLAST CONTROLS

The single slide dimming ballast control dimmer with on/off control, compatible with the ballast and control the ballast light output over the full dimming range, which are approved by the ballast manufacturer.

## 2.5 LIGHT LEVEL SENSOR

Provide UL listed light level sensor capable of detecting changes in ambient lighting levels, with a dimming range of (b) (7)(E), minimum, and designed for use with dimming ballast and voltage system to which they are connected. Provide with sensor capable of controlling (b) (7)(E) electronic dimming ballast, minimum, with a sensor light level adjustable with a set level range from (b) (7)(E). Provide a sensor with a (b) (7)(E).

## 2.6 LIGHTING CONTACTOR

Provide (b) (7)(E), mechanically held contactor, rated (b) (7)(E), with coils rated (b) (7)(E). Rate contactor as indicated. Provide in (b) (7)(E) enclosure conforming to (b) (7)(E). Provide contactor with silver alloy double-break contacts and coil clearing contacts for mechanically held contactor requiring no arcing contacts.

## 2.7 TIME SWITCH

Provide (b) (7)(E). Provide switch rated (b) (7)(E), having (b) (7)(E). Provide time switch with a (b) (7)(E). Surface mount the housing for the time switch, (b) (7)(E) enclosure conforming to (b) (7)(E).

## 2.8 PHOTOCELL SWITCH

Provide photocell switch conforming to (b) (7)(E), t hermetically sealed (b) (7)(E) or (b) (7)(E) type cell rated (b) (7)(E). Provide switch which (b) (7)(E). Provide switch:

- a. Integral to the luminaire, rated (b) (7)(E) (b) (7)(E).

## 2.9 EQUIPMENT IDENTIFICATION

### 2.9.1 Manufacturer's Nameplate

Provide each item of equipment with a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in an inconspicuous place; the nameplate of the distributing agent is not acceptable.

### 2.9.2 Labels

Provide labeled control devices, clearly marked for operation of specific lighting functions according to type.

Make markings related to control device type clear and locate to be readily visible to service personnel, but unseen from normal viewing angles when devices are in place.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

##### 3.1.1 Photoconductive Control Devices

Install photoconductive control devices in accordance with the manufacturer's installation instructions.

##### 3.1.2 Time Control Switches

Install switches with not less than (b) (7)(E). The use of (b) (7)(E) is not allowed.

##### 3.1.3 Manual and Safety Switches

Coordinate terminal lugs with the wire size. Securely fasten switches to the supporting structure or wall using not less than (b) (7)(E). The use of (b) (7)(E) is not allowed.

##### 3.1.4 Magnetic Contactors

Provide magnetic contactors mechanically held, electrically operated, conforming to (b) (7)(E) and (b) (7)(E). Provide with maximum continuous ampere rating and number of poles as indicated on drawings. Provide enclosures for contactors mounted indoors conforming to (b) (7)(E). Provide each contactor with a spare, normally open auxiliary contact.

Coordinate terminal lugs with the wire size. Securely fasten switches to the supporting structure or wall using not less than (b) (7)(E). The use of (b) (7)(E) is not allowed.

#### 3.2 FIELD TESTING

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

Demonstrate that photoconductive control devices operate satisfactorily in the presence of the Contracting Officer.

Perform System Operation Tests in accordance with referenced standards in this section.

-- End of Section --

SECTION 26 23 00.00 40

SWITCHBOARDS AND SWITCHGEAR

02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

(b) (7)(E)

(b) (7)(E)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

(b) (7)(E)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

(b) (7)(E)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

(b) (7)(E)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

(b) (7)(E)

UNDERWRITERS LABORATORIES (UL)

(b) (7)(E)

## 1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

## 1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, use as defined in IEEE Std Dictionary.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

##### SD-02 Shop Drawings

###### Switchboard Drawings; G

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate within the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include submittals for the nameplate data, size, and capacity. Also include submittals for applicable federal, military, industry, and technical society publication references.

##### SD-03 Product Data

###### Switchboard; G

##### SD-06 Test Reports

###### Switchboard Design Tests; G

###### Switchboard Production Tests; G

###### Acceptance Checks And Tests; G

##### SD-10 Operation and Maintenance Data

###### Switchboard Operation and Maintenance, Data Package 5; G

##### SD-11 Closeout Submittals

###### Assembled Operation and Maintenance Manuals; G

###### Equipment Test Schedule; G

###### Request for Settings; G

#### 1.5 QUALITY ASSURANCE

##### 1.5.1 Predictive Testing And Inspection Technology Requirements

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and



systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

#### 1.5.2 Switchboard Product Data

Each submittal shall include manufacturer's information for each component, device and accessory provided with the switchboard including:

- a. Circuit breaker type, interrupting rating, and trip devices, including available settings
- b. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

#### 1.5.3 Switchboard Drawings

Drawings shall include, but are not limited to the following:

- a. One-line diagram including breakers, fuses, current transformers, and meters
- b. Outline drawings including front elevation, section views, footprint, and overall dimensions
- c. Bus configuration including dimensions and ampere ratings of bus bars
- d. Markings and NEMA nameplate data, including fuse information (manufacturer's name, catalog number, and ratings)
- e. Circuit breaker type, interrupting rating, and trip devices, including available settings
- f. Three-line diagrams and elementary diagrams and wiring diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.
- g. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device. These shall be used by the designer of record to provide breaker settings that will ensure protection and coordination are achieved.
- h. Provisions for future extension.

#### 1.5.4 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of (b) (7)(E) unless more stringent requirements are specified or indicated.

#### 1.5.5 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

##### 1.5.5.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

##### 1.5.5.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than 3 years prior to date of delivery to site, unless specified otherwise.

#### 1.6 MAINTENANCE

##### 1.6.1 Switchboard Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

##### 1.6.2 Assembled Operation and Maintenance Manuals

Assemble and bind manuals securely in durable, hard covered, water resistant binders. Assemble and index the manuals in the following order with a table of contents. The contents of the assembled operation and maintenance manuals shall be as follows:

- a. Manufacturer's O&M information required by the paragraph entitled "SD-10, Operation and Maintenance Data".
- b. Catalog data required by the paragraph entitled, "SD-03, Product Data".
- c. Drawings required by the paragraph entitled, "SD-02, Shop Drawings".
- d. Prices for spare parts and supply list.
- e. Information on metering
- f. Design test reports
- g. Production test reports

##### 1.6.3 Spare Parts

Furnish spare parts as specified below. All spare parts shall be of the same material and workmanship, shall meet the same requirements, and shall be interchangeable with the corresponding original parts furnished.

- a. 2 - Fuses of each type and size.

## 1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

## PART 2 PRODUCTS

### 2.1 PRODUCT COORDINATION

Products and materials not considered to be switchboards and related accessories are specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION, Section 33 70 02.00 10 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

### 2.2 SWITCHBOARD

(b) (7)(E)

#### 2.2.1 Ratings

The voltage rating of the switchboard shall be (b) (7)(E). The continuous current rating of the main bus shall be as indicated. The short-circuit current rating shall be as indicated. The switchboard shall be UL listed and labeled for its intended use as service entrance equipment.

#### 2.2.2 Construction

The switchboards shall be dead-front switchboards conforming to (b) (7)(E) and labeled under (b) (7)(E). The switchboards shall be completely enclosed self-supporting metal structures with the required number of vertical panel sections, buses, molded-case circuit breakers, [and other devices] as shown on the drawings. Switchboards shall be fully rated for a short-circuit current (as indicated on the plans).

Switchboard shall consist of vertical sections bolted together to form a rigid assembly and shall be rear aligned. (b) (7)(E). Rear aligned switchboards are to have (b) (7)(E) (b) (7)(E). Compartmentalized switchboards shall have (b) (7)(E) (b) (7)(E). Where indicated, "space for future" or "space" shall mean to include bus, device supports, and connections. Provide insulating barriers in accordance with (b) (7)(E) thickness. Apply moisture resistant coating to all rough-cut edges of barriers. Switchboard shall be completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections, instrumentation, and control wiring.

#### 2.2.2.1 Enclosure

The switchboard enclosure shall be a outdoor (b) (7)(E) fabricated entirely of (b) (7)(E) (b) (7)(E). Enclosure shall be bolted together with (b) (7)(E)

(b) (7)(E) Front doors shall be provided with stainless steel padlockable vault handles with a (b) (7)(E) catch. Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of galvanized steel. Base shall include any part of enclosure that is within (b) (7)(E) of concrete pad. Galvanized steel shall be (b) (7)(E) as applicable. Galvanize after fabrication where practicable. Paint enclosure, including bases, ASTM D 1535 light gray No. 61 or No. 49. Paint coating system shall comply with IEEE C57.12.28 for galvanized steel.

Each switchboard enclosure shall be (b) (7)(E), built with selected smooth sheet steel panels of not less than No. (b) (7)(E). Exposed panels on the front and ends shall have bent angle or channel edges with all corner seams welded and ground smooth. The front outside surfaces shall not be drilled or welded for the purpose of attaching wires or mounting devices if such holes or fastenings will be visible from the front. The front panels shall be made in sections flanged on four sides and attached to the framework by screws and arranged for ready removal for inspection or maintenance. Rear access to the bus and device connections shall be provided. Ventilating openings shall be provided as required and shall preferably be of the grille type. All ventilating openings shall be provided with corrosion-resistant insect-proof screens on the inside. Mount switchboards as shown on the drawings and furnish mounting materials as indicated. Treat all interior and exterior steel parts to inhibit corrosion and paint.

#### 2.2.2.2 Bus Bars

Bus bars shall be copper with silver-plated contact surfaces. Plating shall be a minimum of (b) (7)(E) thick. Make bus connections and joints with (b) (7)(E). The through-bus shall be rated at the full ampacity of the main throughout the switchboard. Provide minimum (b) (7)(E) ground bus secured to each vertical section along the entire length of the switchboard. The neutral bus shall be rated 100 percent of the main bus continuous current rating.

All buses shall be of (b) (7)(E) and all bolted splices and connections between buses and for extensions or taps for equipment shall be (b) (7)(E) throughout. (b) (7)(E) bars and shapes for bus conductors shall conform to the applicable requirements of (b) (7)(E). All splices for field assembly shall be bolted with at least two bolts and shall employ the use of "Belleville" washers in the connection. Horizontal and vertical power buses have minimum current ratings as shown on the drawings. The buses shall be insulated for not less than (b) (7)(E). Shop splices and tap connections shall be (b) (7)(E). All splices for field assembly shall be (b) (7)(E). Mount the buses on insulating supports of (b) (7)(E) suitable molded material, and brace to withstand not less than (b) (7)(E). A copper ground bus, rated not less than (b) (7)(E), extending the entire length of the assembled structure, shall be (b) (7)(E) of enclosure. A (b) (7)(E) (b) (7)(E) shall be provided at each end of the bus for connection to the station grounding system.

#### 2.2.2.3 Main Section

The main section shall consist of molded-case circuit breaker.

#### 2.2.2.4 Distribution Sections

The distribution section[s] shall consist of molded-case circuit breakers as indicated.

#### 2.2.2.5 Combination Sections

Combination sections shall consist of molded-case circuit breakers for the main and branch devices as indicated.

#### 2.2.2.6 Auxiliary Sections

Auxiliary sections shall consist of indicated instruments, metering equipment, control equipment, transformer, and current transformer compartments as indicated.

#### 2.2.2.7 Handles

Handles for individually mounted devices shall be of the same design and method of external operation. Label handles prominently to indicate device ampere rating, color coded for device type. Identify ON-OFF indication by handle position and by prominent marking.

#### 2.2.3 Protective Device

Provide main and branch protective devices as indicated.

##### 2.2.3.1 Power Circuit Breaker

(b) (7)(E) Vac manually operated stationary low-voltage power circuit breaker with a short-circuit current rating as indicated at (b) (7)(E). Breaker frame size shall be as indicated.

##### 2.2.3.2 Molded-Case Circuit Breaker

(b) (7)(E) UL listed and labeled, 100 percent rated, stationary, (b) (7)(E) manually operated, low voltage molded-case circuit breaker, with a short-circuit current rating as indicated at (b) (7)(E). Breaker frame as indicated. Series rated circuit breakers are unacceptable.

Equip each switchboard with molded-case circuit breakers with trip ratings and terminal connectors for attachment of outgoing power cables as shown on the drawings. The circuit breakers shall be operable and (b) (7)(E). Where shown on the drawings, enclose circuit breakers in individual compartments.

##### 2.2.3.3 Fusible Switches

Fusible Switches: Quick-make, quick-break, hinged-door type. Switches serving as motor disconnects shall be horsepower rated. Fuses shall be current-limiting cartridge type conforming to U (b) (7)(E).

Fuseholders: (b) (7)(E)

##### 2.2.3.4 Integral Combination Breaker and Current-Limiting Fuses

(b) (7)(E). Provide integral combination molded-case circuit breaker and current-limiting fuses as indicated with a minimum short-circuit-current rating equal to the short-circuit-current rating of the [switchboard][switchgear] in which the circuit breaker will be mounted. Series rated circuit breakers are unacceptable. Coordination of overcurrent devices of the circuit breaker and current-limiting fuses shall be such that on overloads or fault currents of relatively low value, the overcurrent device of the breaker will be operated to clear the fault. For high magnitude short circuits above a predetermined value[ crossover point], the current-limiting fuses shall operate to clear the fault. Housing for the current-limiting fuses shall be an individual molding readily removable from the front and located at the load side of the circuit breaker. (b) (7)(E)

(b) (7)(E)

#### [2.2.4 Transformer

Provide transformer section in switchboard in accordance with (b) (7)(E) and as indicated. The transformer and section shall be suitable for the installation. Transformers greater than (b) (7)(E) shall be tested in accordance with (b) (7)(E).

#### 2.2.5 Terminal Boards

Provide with (b) (7)(E). Terminal boards associated with current transformers shall be (b) (7)(E) type. Terminate conductors for current transformers with (b) (7)(E). Terminal board identification shall be identical in similar units. External wiring shall be color coded consistently for similar terminal boards.

#### 2.2.6 Wire Marking

Mark control and metering conductors at each end. Provide factory-installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Each sleeve shall contain a single letter or number, shall be elliptically shaped to securely grip the wire, and shall be keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Each wire marker shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached.

#### 2.3 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

#### 2.4 FIELD FABRICATED NAMEPLATES

(b) (7)(E). Provide laminated plastic nameplates for each[ switchboard,][ switchgear,] equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

#### 2.5 SOURCE QUALITY CONTROL

##### 2.5.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

- (1) The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
- (2) The accuracy shall be directly traceable to the National Institute of Standards and Technology.
- (3) Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.
- (4) Dated calibration labels shall be visible on all test equipment.
- (5) Calibrating standard shall be of higher accuracy than that of the instrument tested.
- (6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:
  - (a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.
  - (b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.5.2 Switchboard Design Tests

(b) (7)(E)

2.5.2.1 Design Tests

Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.

- a. Short-circuit current test
- b. Enclosure tests
- c. Dielectric test

2.5.2.2 Additional design tests

In addition to normal design tests, perform the following tests on the actual equipment. Furnish reports which include results of design tests performed on the actual equipment.

- a. Temperature rise tests
- b. Continuous current

2.5.3 Switchboard Production Tests

(b) (7)(E). Furnish reports which include results of production tests performed on the actual equipment for this project. These tests include:

- a. (b) (7)(E) dielectric tests
- b. Mechanical operation tests
- c. Electrical operation and control wiring tests
- d. Ground fault sensing equipment test

## PART 3 EXECUTION

### 3.1 INSTALLATION

Electrical installations shall conform to (b) (7)(E), and to the requirements specified herein.

### 3.2 GROUNDING

(b) (7)(E), except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding (b) (7)(E).

#### 3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

#### 3.2.2 Equipment Grounding

Provide (b) (7)(E) connecting to the indicated ground rods. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

#### 3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Exothermic welds and compression connectors shall be installed as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION, paragraph entitled, "Grounding Connections."

#### 3.2.4 Grounding and Bonding Equipment

(b) (7)(E) except as indicated or specified otherwise.

### 3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

#### 3.3.1 Switchboard

(b) (7)(E)

#### 3.3.2 Field Applied Painting



Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

### 3.3.3 Galvanizing Repair

Repair damage to galvanized coatings using (b) (7)(E), zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

### 3.3.4 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

## 3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

### 3.4.1 Exterior Location

Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least (b) (7)(E) [REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]. Seal voids around conduit openings in slab with (b) (7)(E). (b) (7)(E) [REDACTED]. Concrete work shall be as specified in Section [03 30 00 CAST-IN-PLACE CONCRETE][ 03 30 00.00 10 CAST-IN-PLACE CONCRETE][ 03 35 00.00 10 CONCRETE FINISHING][ 03 39 00.00 10 CONCRETE CURING].

## 3.5 FIELD QUALITY CONTROL

Contractor shall submit request for settings of breakers to the Contracting Officer after approval of switchboard and at least 30 days in advance of their requirement.

### 3.5.1 Performance of Acceptance Checks and Tests

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

#### 3.5.1.1 Switchboard Assemblies

##### a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical, electrical, and mechanical condition.
- (3) Confirm correct application of manufacturer's recommended lubricants.

- (4) Verify appropriate anchorage, required area clearances, and correct alignment.
- (5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
- (6) Verify that fuse and circuit breaker sizes and types correspond to approved shop drawings.
- (7) Verify that current transformer ratios correspond to approved shop drawings.
- (8) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.
- (9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
- (10) Clean switchboard.
- (11) Inspect insulators for evidence of physical damage or contaminated surfaces.
- (12) Verify correct barrier and shutter installation and operation.
- (13) Exercise all active components.
- (14) Inspect all mechanical indicating devices for correct operation.
- (15) Verify that vents are clear.
- (16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.
- (17) Inspect control power transformers.

b. Electrical Tests

- (1) Perform insulation-resistance tests on each bus section.
- (2) Perform overpotential tests.
- (3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.
- (4) Perform control wiring performance test.
- (5) Perform primary current injection tests on the entire current circuit in each section of assembly.
- (6) Perform phasing check on double-ended switchboard to ensure correct bus phasing from each source.

3.5.1.2 Circuit Breakers - Low Voltage - Power

a. Visual and Mechanical Inspection

- (1) Compare nameplate data with specifications and approved shop drawings.

- (2) Inspect physical and mechanical condition.
- (3) Confirm correct application of manufacturer's recommended lubricants.
- (4) Inspect anchorage, alignment, and grounding. Inspect arc chutes. Inspect moving and stationary contacts for condition, wear, and alignment.
- (5) Verify that all maintenance devices are available for servicing and operating the breaker.
- (6) Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
- (7) Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.
- (8) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.
- (9) Verify cell fit and element alignment.
- (10) Verify racking mechanism.

b. Electrical Tests

- (1) Perform contact-resistance tests on each breaker.
- (2). Perform insulation-resistance tests.
- (3) Adjust Breaker(s) for final settings in accordance with Government provided settings.
- (4).. Determine long-time minimum pickup current by primary current injection.
- (5) Determine long-time delay by primary current injection.

### 3.5.1.3 Circuit Breakers

#### Low Voltage Molded Case with Solid State Trips

a. Visual and Mechanical Inspection

- (1) Compare nameplate data with specifications and approved shop drawings.
- (2) Inspect circuit breaker for correct mounting.
- (3) Operate circuit breaker to ensure smooth operation.
- (4) Inspect case for cracks or other defects.

- (5) Inspect all bolted electrical connections for high resistance using low resistance ohmmeter, verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method, or performing thermographic survey.

- (6) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

- (1) Perform contact-resistance tests.

- (2) Perform insulation-resistance tests.

- (3) Perform Breaker adjustments for final settings in accordance with Government provided settings.

- (4) Perform long-time delay time-current characteristic tests.

3.5.1.4 Current Transformers

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.

- (2) Inspect physical and mechanical condition.

- (3) Verify correct connection.

- (4) Verify that adequate clearances exist between primary and secondary circuit.

- (5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

- (6) Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

- (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

- (2) Perform insulation-resistance tests.

- (3) Perform polarity tests.

- (4) Perform ratio-verification tests.

3.5.1.5 Grounding System

a. Visual and Mechanical Inspection

- (1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

- (1) (b) (7)(E) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.
- (2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

### 3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

SECTION 26 24 16.00 40

PANELBOARDS

08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

(b) (7)(E)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

(b) (7)(E)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

(b) (7)(E)

UNDERWRITERS LABORATORIES (UL)

(b) (7)(E)

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Submit Detail Drawings for the panelboards consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents. Include within drawings details of bus layout.

Ensure Outline Drawings for panelboards indicate overall physical features, dimensions, ratings, service requirements, and weights of equipment.

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. Statements must be dated after the award of this contract, name the project, and list the specific requirements which it is intended to address.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Submit Detail Drawings and Outline Drawings for panelboards in accordance with paragraph entitled, "General Requirements," of this section.

#### SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Panelboards

Directory Card and Holder

Filtered Panelboard

#### SD-04 Samples

Ensure that Keys are properly tagged and delivered to the Contracting Officer.

#### SD-06 Test Reports

Submit test reports for the following tests in accordance with the paragraph entitled, "Site Testing," of this section. Do not energize panelboards until the recorded test data has been submitted to and approved by the Contracting Officer.

Continuity Tests

Insulation Tests

#### SD-07 Certificates

Submit Statements in accordance with paragraph entitled, "General Requirements," of this section.

#### SD-08 Manufacturer's Instructions

Submit manufacturer's instructions for Panelboards including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

### 1.4 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that

shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

## PART 2 PRODUCTS

### 2.1 PANELBOARDS

Totally enclose power-distribution panelboards and lighting and appliance branch-circuit panelboards in a (b) (7)(E)

Ensure panelboards conform to (b) (7)(E) 1. Branch circuit panels shall have buses fabricated for (b) (7)(E) type circuit breakers.

An outer door or cover, hinged on one side, shall be provided on surface-mounted panelboards to provide gutter space access. Provide a center door for circuit breaker/switch access only.

Voltage and current rating, number of phases, and number of wires shall be as indicated. Provide (b) (7)(E) panelboards and lighting and appliance branch-circuit panelboards with an isolated full-capacity neutral bus. Ensure panelboards are rated for (b) (7)(E).

Provide (b) (7)(E) distribution lighting and branch circuit panelboards with an isolated full-capacity bus providing spaces for single-pole circuit breakers/switches and spaces indicated as spare.

Provide panelboards with a separate grounding bus bonded to the enclosure. Grounding bus shall be a solid bus bar of rectangular cross section equipped with binding screws for the connection of equipment grounding conductors.

Each panelboard, as a complete unit, shall have a short-circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or as indicated.

Ensure panelboards and main lugs or main breaker have current ratings as shown on the panelboard schedule.

Bus bar connections to the branch circuit breakers shall be the (b) (7)(E) " or " (b) (7)(E) " type. (b) (7)(E)

(b) (7)(E)  
(b) (7)(E)  
(b) (7)(E)  
(b) (7)(E) Mains ratings shall be as shown.

Mechanical lugs furnished with panelboards shall be (b) (7)(E) of sizes suitable for the conductors indicated to be connected thereto.

Boxes shall have the manufacturer's standard knockouts and shall be (b) (7)(E). Fronts shall be of (b) (7)(E) furnished with hinged doors with adjustable trim clamps for securing the fronts to the boxes.

Panelboard box shall be (b) (7)(E)  
(b) (7)(E)  
(b) (7)(E) Where panelboards are installed flush with the walls, the installation details shall be such that the



hinged front can be opened without damage to the adjacent wall surfaces. Ensure that the color of the finished coat of trim and front matches the adjacent walls except when the box is installed in electrical closets or equipment rooms, the gray finish as specified is acceptable.

Panelboard enclosures shall be (b) (7)(E). Provide enclosures with hinged fronts and corrosion-resistant (b) (7)(E).

Finish panelboards with baked enamel. Finish color is to be No. 61 gray conforming to FED-STD-595.

## 2.2 CIRCUIT BREAKERS

Circuit breakers shall be the molded-case type as specified in Section 26 05 70.00 40 HIGH VOLTAGE OVERCURRENT PROTECTIVE DEVICES and Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Frame and trip ratings shall be as indicated.

Interrupting rating of circuit breakers shall be as indicated. If not shown, the interrupting rating for circuit breakers (b) (7)(E) panelboards shall be not less than (b) (7)(E), and that for breakers in (b) (7)(E) panelboards shall be not less than (b) (7)(E) symmetrical.

Circuit breakers shall be (b) (7)(E). (b) (7)(E) is not acceptable.

Provide (b) (7)(E) where indicated.

In branch circuit panelboards, branch circuit breakers feeding convenience outlets shall have (b) (7)(E)

This protection is an integral part of the branch circuit breaker that also provides (b) (7)(E)

(b) (7)(E)

Ensure connections to the bus are (b) (7)(E).

When multiple wires per phase are specified, furnish the circuit breakers with connectors made to accommodate multiple wires.

Ensure circuit breaker spaces called out on the drawings are complete with mounting hardware to permit ready installation of the circuit breakers.

## 2.3 DIRECTORY CARD AND HOLDER

Mount a directory card on the inside of hinged fronts and doors (b) (7)(E) in a metal frame, with spaces for circuit numbers, outlets controlled, and room numbers. Where hinged fronts or doors are not required, provide the directory card 0.030-inch thick minimum plastic in a metal frame mounted on the left-hand side of the front trim. Directory card shall identify each branch circuit with its respective and numbered circuit breaker.

## 2.4 FACTORY TESTING

Test complete panelboards in accordance with (b) (7)(E)

## 2.5 PRECAUTIONARY LABEL

To ensure persons are aware of immediate or potential hazard in the application, installation, use, or maintenance of panelboards, each panelboard shall be conspicuously marked on the trim or dead front shield with the text (or equivalent) **DANGER** symbol. If the panel is supplied with a door, ensure the label is visible when the door is in the open position.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Install panelboards as indicated and in accordance with the manufacturer's instructions. Fully align and mount panels so that the height of the top operating handle does not exceed (b) (7)(E)s above the finished floor.

Directory-card information shall be typewritten in capital letters to indicate outlets controlled and final room numbers served by each circuit and shall be mounted in holders behind protective covering.

### 3.2 SITE TESTING

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

Each panelboard enclosure key shall be shown to operate the enclosure locks in the presence of the Contracting Officer.

Panelboards shall be given continuity and insulation tests after the installation has been completed and before the panelboard is energized.

Provide test equipment, labor, and personnel as required to perform the tests as specified. Conduct Continuity tests using a dc device with buzzer.

Conduct insulation tests on (b) (7)(E) panelboards using a (b) (7)(E) insulation-resistance test set. Record readings every minute until three equal and consecutive readings have been obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than (b) (7)(E).

Conduct insulation tests on panelboards rated (b) (7)(E) minimum insulation-resistance test set. Record readings after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than (b) (7)(E).

Record test data and include the location and identification of panelboards and megohm readings versus time.

-- End of Section --

SECTION 26 56 00

EXTERIOR LIGHTING

07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)

(b) (7)(E)

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

(b) (7)(E)

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

(b) (7)(E)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

(b) (7)(E)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

(b) (7)(E)

(b) (7)(E)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

(b) (7)(E)

U.S. DEPARTMENT OF AGRICULTURE (USDA)

(b) (7)(E)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

(b) (7)(E)

UNDERWRITERS LABORATORIES (UL)

(b) (7)(E)

## 1.2 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in (b) (7)(E)
- b. Average life is the time after which 100 percent will have failed and 100 percent will have survived under normal conditions.
- c. Groundline section is that portion between (b) (7)(E) the groundline.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

Luminaire drawings; G, [\_\_\_\_\_]

Poles; G, [\_\_\_\_\_]

### SD-03 Product Data

[Local/Regional Materials]

Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.]

[Environmental Data]

Energy Efficiency

Luminaires; G, [\_\_\_\_\_]

Lamps; G, [\_\_\_\_\_]

Ballasts; G, [\_\_\_\_\_]

Lighting contactor; G, [\_\_\_\_\_]

Time switch; G, [\_\_\_\_\_]

Photocell switch; G, [\_\_\_\_\_]

Concrete poles; G, [\_\_\_\_\_]

Aluminum poles; G, [\_\_\_\_\_]

Steel poles; G, [\_\_\_\_\_]

Fiberglass poles; G, [\_\_\_\_\_]

Brackets

[Auxiliary instant-on quartz system; G, [\_\_\_\_\_]]

Luminaires; G, [\_\_\_\_\_]

Submit one sample of each luminaire type[, complete with lamp and ballast]. [ Submit one sample for each item other than luminaires.] Sample will be returned to the Contractor for installation in the project work.

] SD-05 Design Data

Design Data for luminaires; G, [\_\_\_\_\_]

SD-06 Test Reports

[Pressure treated wood pole quality]

[Tests for fiberglass poles; G, [\_\_\_\_\_]]

Operating test

Submit operating test results as stated in paragraph entitled "Field Quality Control."

#### SD-o8 Manufacturer's Instructions

Concrete poles

Submit instructions prior to installation.

Fiberglass poles

Submit instructions prior to installation.

#### SD-10 Operation and Maintenance Data

Operational Service

Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

### 1.4 QUALITY ASSURANCE

#### 1.4.1 Drawing Requirements

##### 1.4.1.1 Luminaire Drawings

Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and [computerized] candlepower distribution data shall accompany shop drawings.

##### 1.4.1.2 Poles

Include dimensions, wind load determined in accordance with (b) (7)(E) pole deflection, pole class, and other applicable information. [ For concrete poles, include: section and details to indicate quantities and position of prestressing steel, spiral steel, inserts, and through holes; initial prestressing steel tension; and concrete strengths at release and at 28 days.]

#### 1.4.2 Pressure Treated Wood Pole Quality

Ensure the quality of pressure treated wood poles. Furnish an inspection report (for wood poles) of an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with (b) (7)(E). The RUS approved Quality Mark "WQC" on each pole will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWP treatment standards.

#### 1.4.3 Design Data for Luminaires

- a. Distribution data according to (b) (7)(E) classification type as defined in (b) (7)(E)
- b. Computerized horizontal illumination levels in footcandles at ground level, taken every (b) (7)(E). Include average maintained footcandle level and maximum and minimum ratio.

#### [1.4.4 Tests for Fiberglass Poles

- a. Ultraviolet resistance tests: Perform according to (b) (7)(E) hours minimum with the following results:

Fiber exposure: None  
Crazing: None  
Checking: None  
Chalking: None  
Color: May dull slightly

- b. Flexural strength and deflection test: Test loading shall be as a cantilever beam with pole butt as fixed end and a force simulating wind load at the free end.

#### ]1.4.5 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of (b) (7)(E) unless more stringent requirements are specified or indicated.

#### 1.4.6 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

##### 1.4.6.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

##### 1.4.6.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

##### [1.5.1 Wood Poles

Stack poles stored for more than 2 weeks on decay-resisting skids arranged to support the poles without producing noticeable distortion. Store poles to permit free circulation of air; the bottom poles in the stack shall be at least one foot above ground level and growing vegetation. Do not permit decayed or



decaying wood to remain underneath stored poles. Do not drag treated poles along the ground. Do not use pole tongs, cant hooks, and other pointed tools capable of producing indentation more than one inch in depth in handling the poles. Do not apply tools to the groundline section of any pole.

#### ][1.5.2 Concrete Poles

Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation.

#### ][1.5.3 Fiberglass Poles

Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

#### ][1.5.4 [Aluminum ][Steel ]Poles

Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

### ]1.6 SUSTAINABLE DESIGN REQUIREMENTS

#### 1.6.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [500][\_\_\_\_\_] mile radius from the project site, if available from a minimum of three sources.

#### 1.6.2 Environmental Data

[Submit Table 1 of (b) (7)(E) for the following products: [\_\_\_\_].]

#### 1.6.3 Energy Efficiency

Comply with National Energy Policy Act and Energy Star requirements for lighting products. [Submit documentation for Energy Star qualifications for equipment provided under this section. ]Submit data indicating lumens per watt efficiency and color rendition index of light source.

### 1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

### 1.8 POWER SOURCE

[Use a (b) (7)(E) power source.]

### 1.9 OPERATIONAL SERVICE

Coordinate with manufacturer for [maintenance agreement] [take-back program]. Collect information from the manufacturer about [maintenance agreement] [green lease] options, and submit to Contracting Officer. Services shall reclaim materials for recycling and/or reuse. Services shall not landfill or burn reclaimed materials. Indicate procedures for compliance with regulations governing disposal of mercury. When such a service is not available, local recyclers shall be sought after to reclaim the materials.

## PART 2 PRODUCTS

### 2.1 PRODUCT COORDINATION

Products and materials not considered to be lighting equipment or lighting fixture accessories are specified in[ Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION,] Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION,[ Section 33 70 02.00 10 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND,][ and] Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.[ Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in Section 26 51 00 INTERIOR LIGHTING.]

### 2.2 LUMINAIRES

(b) (7)(E). Provide luminaires as indicated. Provide luminaires complete with lamps of number, type, and wattage indicated. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs[, light distribution and brightness characteristics,] and of equal finish and quality will be acceptable as approved.

#### 2.2.1 Lamps

##### 2.2.1.1 High-Pressure Sodium (HPS) Lamps

(b) (7)(E). Wattage as indicated. HPS lamps shall have average rated life of (b) (7)(E)

. Lamps shall have Luminaire Efficiency Ratings (LER) as follows:

##### a. Upward efficiency of (b) (7)(E) percent

1. (b) (7)(E)

2.

##### b. Upward efficiency of (b) (7)(E) percent

1. (b) (7)(E)

2.

3.

##### c. Upward efficiency of (b) (7)(E) percent

1. (b) (7)(E)

2.

##### d. Upward efficiency greater than (b) (7)(E) percent

(b) (7)(E)

[2.2.1.2 Standby HPS Lamps

(b) (7)(E). Wattage as indicated. Standby HPS lamps shall have (b) (7)(E), minimum, of total light output. (b) (7)(E) watt lamps, if required, shall be (b) (7)(E) volt type.

]2.2.1.3 Low-Pressure Sodium (LPS) Lamps

(b) (7)(E).

]2.2.1.4 Metal-Halide Lamps

Provide luminaires with (b) (7)(E)

[a. (b) (7)(E)]

((b) (7)(E)

Lamps shall have Luminaire Efficiency Ratings (LER) as follows:

a. Upward efficiency of (b) (7)(E) percent

1. (b) (7)(E)  
2. (b) (7)(E)  
3. (b) (7)(E)

b. Upward efficiency of (b) (7)(E) percent

1. (b) (7)(E)  
2. (b) (7)(E)  
3. (b) (7)(E)

c. Upward efficiency greater than (b) (7)(E) percent

1. (b) (7)(E)  
2. (b) (7)(E)

]2.2.2 Ballasts for High-Intensity-Discharge (HID) Luminaires

(b) (7)(E), and shall be (b) (7)(E). Ballasts shall be:

- a. Designed to operate on voltage system to which they are connected.
- b. Constructed so that open circuit operation will not reduce the average life.

HID ballasts shall have a (b) (7)(E) Igniter case temperature shall not exceed (b) (7)(E) degrees C.

### 2.3 LIGHTING CONTACTOR

(b) (7)(E) electrically][ mechanically] held contactor.[ Contacts shall be rated [ ] volts, [ ] amperes, and [ ] poles. Coils shall be rated [ ] volts.][ Rate contactor as indicated.] Provide in (b) (7)(E) enclosure conforming to (b) (7)(E) Contactor shall have (b) (7)(E) [ Provide contactor (b) (7)(E) ][ Contactor shall be (b) (7)(E) .]

### 2.4 TIME SWITCH

(b) (7)(E) Provide switch rated [ ] volts, having automatically wound spring mechanism or capacitor, to maintain accurate time for a minimum of (b) (7)(E) . Provide time switch with a (b) (7)(E) Housing for the time switch shall be surface mounted, (b) (7)(E) ][ ] enclosure conforming to (b) (7)(E)

### 2.5 PHOTOCELL SWITCH

(b) (7)(E) Provide switch:

[a. (b) (7)(E) ]

[b. (b) (7)(E) .]

[c. (b) (7)(E) ]

[d. Integral to the luminaire, rated (b) (7)(E), minimum.]

### 2.6 POLES

Provide poles designed for (b) (7)(E) determined in accordance with (b) (7)(E) while supporting luminaires and all other appurtenances indicated. The effective projected areas of luminaires and appurtenances used in calculations shall be specific for the actual products provided on each pole. Poles shall be[ embedded][ anchor]-base type designed for use with[ underground][ overhead] supply conductors.[ Poles[, other than wood poles,] shall have oval-shaped handhole having a minimum clear opening (b) (7)(E) Handhole cover shall be secured by stainless steel captive screws.][ (b) (7)(E) ] Scratched, stained, chipped, or dented poles shall not be installed.

### 2.6.1 Concrete Poles

Provide concrete poles conforming to (b) (7)(E). Cross-sectional shape shall be [ round ][ or ][ multi-sided ].

#### 2.6.1.1 Steel Reinforcing

Prestressed concrete pole shafts shall be (b) (7)(E). Design shall provide internal longitudinal loading by either pretensioning or post tensioning of longitudinal reinforcing members.

#### 2.6.1.2 Tensioned Reinforcing

Primary reinforcement steel used for a prestressed concrete pole shaft shall be tensioned (b) (7)(E). The amount of reinforcement shall be such that when reinforcement is tensioned to (b) (7)(E), the total resultant tensile force does not exceed the minimum section compressive strength of the concrete.

#### 2.6.1.3 Coating and Sleeves for Reinforcing Members

Where minimum internal coverage cannot be maintained next to required core openings, such as (b) (7)(E), reinforcing shall be protected with a vaporproof noncorrosive sleeve over the length without the (b) (7)(E) concrete coverage. Each steel reinforcing member which is to be post-tensioned shall have a nonmigrating slipper coating applied prior to the addition of concrete to ensure uniformity of stress throughout the length of such member.

#### 2.6.1.4 Strength Requirement

As an exception to the requirements of (b) (7)(E), poles shall be naturally cured to achieve a 28-day (b) (7)(E). Poles shall not be subjected to severe temperature changes during the curing period.

#### 2.6.1.5 Shaft Preparation

Completed prestressed concrete pole shaft shall have a hard, smooth, nonporous surface that is (b) (7)(E), and shall be clean, smooth, and free of surface voids and internal honeycombing. Poles shall not be installed for at least 15 days after manufacture.

### 2.6.2 Aluminum Poles

Provide aluminum poles manufactured of corrosion resistant aluminum alloys conforming to (b) (7)(E) for cast alloys. Poles shall be seamless extruded or spun seamless type with minimum (b) (7)(E) wall thickness. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Tops of shafts shall be fitted with a round or tapered cover. Base shall be (b) (7)(E) and shall be machined to receive the lower end of shaft. Joint between shaft and base shall be welded. Base cover shall be (b) (7)(E). [ Aluminum poles and brackets for [walkway][ ] lighting shall have a [ uniform satin ][ dark anodic bronze ][ ] finish to match fixtures and shall not be painted.] Manufacturer's standard provision shall be made for protecting the finish during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.

### 2.6.3 Steel Poles

(b) (7)(E) Provide steel poles having minimum (b) (7)(E) with minimum yield/strength of (b) (7)(E) [[ iron-oxide primed] factory finish. Provide a pole grounding connection designed to prevent electrolysis when used with (b) (7)(E) ground wire. Pole shall be (b) (7)(E) type. Poles shall have tapered tubular members, either round in cross section or polygonal. [ Pole shafts shall be (b) (7)(E). Poles shall be (b) (7)(E). ] Pole markings shall be approximately 3 to 4 feet above grade and shall include manufacturer, year of manufacture, top and bottom diameters, and length. [ Base covers for steel poles shall be structural quality (b) (7)(E). ]

### 2.6.4 Wood Poles

(b) (7)(E) [ \_\_\_\_ ]. Poles shall be gained, bored, and roofed before treatment. Poles shall be treated full length with chromated copper arsenate (CCA) or ammoniacal copper arsenate (ACA) according to (b) (7)(E) as referenced in (b) (7)(E). Poles shall be branded by manufacturer with manufacturer's mark and date of treatment, height and class of pole, wood species, preservation code, and retention. Place the brand so that the bottom of the brand or disc is 10 feet from the pole butt for poles up to (b) (7)(E) feet long [ and 14 feet from the butt for poles over (b) (7)(E) feet long].

### 2.6.5 Fiberglass Poles

(b) (7)(E). Designed specifically for supporting luminaires and having factory-formed cable entrance and handhole. Resin color shall be [ dark bronze] [ as indicated] [ \_\_\_\_ ], and pigment shall provide uniform coloration throughout entire wall thickness. Finish surface shall be pigmented polyurethane having a minimum dry film thickness of 1.5 mils. Polyurethane may be omitted if the surface layer of the pole is inherently ultraviolet inhibited. Minimum fiberglass content shall be (b) (7)(E)

## 2.7 BRACKETS AND SUPPORTS

(b) (7)(E) as applicable. Pole brackets shall be not less than (b) (7)(E) [ (b) (7)(E) ] secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets shall be coordinated to luminaires provided, and brackets for use with one type of luminaire shall be identical. Brackets for pole-mounted street lights shall correctly position luminaire no lower than mounting height indicated. Mount brackets not less than (b) (7)(E) above street. Special mountings or brackets shall be as indicated and shall be of metal which will not promote galvanic reaction with luminaire head.

## 2.8 POLE FOUNDATIONS

Anchor bolts shall be steel rod having a minimum yield strength of (b) (7)(E) Concrete shall be as specified in [ Section 03 30 00 CAST-IN-PLACE CONCRETE] [ Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE].

## 2.9 AUXILIARY INSTANT-ON QUARTZ SYSTEM

UL listed, automatically switched instant-on (b) (7)(E) -watt [ quartz] [ \_\_\_\_ ] lamp. Quartz lamp shall come on when the luminaire is initially energized (b) (7)(E). Wiring for quartz lamp shall

be internal to ballast and independent of incoming line voltage to the ballast.[ Provide instant-on quartz system for each HID fixture.][ Provide instant-on quartz system as indicated.]

## 2.10 EQUIPMENT IDENTIFICATION

### 2.10.1 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

### 2.10.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. Luminaires shall be clearly marked for operation of specific lamps and ballasts according to proper lamp type. The following lamp characteristics shall be noted in the format "Use Only \_\_\_\_\_":

- a. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
- b. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
- c. Start type ( (b) (7)(E) ) for fluorescent and compact fluorescent luminaires.
- d. ANSI ballast type (b) (7)(E) , etc.) for HID luminaires.
- e. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

Markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

## 2.11 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of (b) (7)(E) test.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Electrical installations shall conform to (b) (7)(E) , and to the requirements specified herein.

#### [3.1.1 Wood Poles

Pole holes shall be at least as large at the top as at the bottom and shall be large enough to provide 4 inches of clearance between the pole and the side of the hole.

- a. Setting depth: Pole setting depths shall be as follows:

Length of Pole (feet)

Setting in Soil (feet)

(b) (7)(E)

(b) (7)(E)

b. Soil setting: "Setting in Soil" depths shall apply where pole holes are in (b) (7)(E) or any combination of these.[ At corners, dead ends and other points of extra strain, poles (b) (7)(E) long or more shall be set (b) (7)(E) deeper.]

c. Setting on sloping ground: On sloping ground, measure the depth of the hole from the low side of the hole.

d. Backfill: Tamp pole backfill for the full depth of the hole and mound the excess fill around the pole.

#### ][3.1.2 Concrete Poles

Install according to pole manufacturer's instructions.

#### ][3.1.3 Fiberglass Poles

Install according to pole manufacturer's instructions.

#### ][3.1.4 [Aluminum][Steel] Poles

Provide pole foundations with (b) (7)(E). Provide ornamental covers to match pole and galvanized nuts and washers for anchor bolts. Concrete for anchor bases, polyvinyl chloride (PVC) conduit ells, and ground rods shall be as specified in Section[33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION][ 33 70 02.00 10 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND]. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.[ After installation, paint exposed surfaces of steel poles with two finish coats of exterior oil paint of a color as indicated][ aluminum paint].

#### ]3.1.5 Pole Setting

[Depth shall be as indicated. ][Poles in straight runs shall be in a straight line. Dig holes large enough to permit the proper use of tampers to the full depth of the hole. Place backfill in the hole in 6 inch maximum layers and thoroughly tamp. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.]

#### 3.1.6 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations.[ Mount switch on or beside each luminaire when switch is provided in cast weatherproof aluminum housing with swivel arm.][ Set adjustable window slide for [\_\_\_\_\_] footcandles photocell turn-on.]

#### 3.1.7 GROUNDING



Ground noncurrent-carrying parts of equipment including[ metal poles,] luminaires, mounting arms, brackets, and metallic enclosures as specified in Section[ 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION][ 33 70 02.00 10 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND]. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

#### 3.1.8 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

#### 3.2 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that the equipment operates in accordance with the requirements of this section.

-- End of Section --

SECTION 28 05 26.00 40

GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY  
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

(b) (7)(E)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

(b) (7)(E)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

(b) (7)(E)

U.S. DEPARTMENT OF DEFENSE (DOD)

(b) (7)(E)

UNDERWRITERS LABORATORIES (UL)

(b) (7)(E)

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit material, equipment, and fixture lists for Grounding Systems including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

#### SD-02 Shop Drawings

Submit Record Drawings in accordance with paragraph entitled, "Drawings," of this section.

#### SD-03 Product Data

Submit equipment and performance data for the following items including life, test, system functional flows, safety features, and mechanical automated details.

Submit Manufacturer's catalog data for the following items:

Ground Rods

Ground Wires

Connectors and Fasteners

Bonding

#### SD-06 Test Reports

Submit Test Reports for the following tests on grounding systems in accordance with the paragraph entitled, "Field Tests," of this section. Within the report include certified record of ground-resistance tests on each driven ground rod, ground rod assembly, and other grounding electrodes. Include within the record the number of rods driven and their depth at each location to meet the required resistance-to-ground measurements specified. Include a statement describing the condition of the soil at the time of measurement.

Bond Resistance Test

Ground Resistance Tests

Ground Isolation Test

Continuity Isolation Test

#### SD-08 Manufacturer's Instructions

Submit Manufacturer's instructions for the Grounding Systems including special provisions required to install equipment components and system packages. Within special notices, detail impedances, hazards and safety precautions.

### 1.4 DRAWINGS

Record Drawings must indicate the location of ground rods, mats, grids, building ground bus, supplementary grounding electrodes, steel building columns, and other metal structures connected to the grounding system.

Identify the location of each ground rod and ground-rod assembly and other grounding electrodes by letter in alphabetical order and keyed to the record of ground-resistance tests.

## 1.5 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

## PART 2 PRODUCTS

### 2.1 GROUND RODS

Ground rods must conform to the requirements of (b) (7)(E).

Ground rods must be (b) (7)(E) rods not less than (b) (7)(E) in diameter and not less than (b) (7)(E) per section. Ground rods must be clean and smooth and have a cone-shaped point on the first section and be die-stamped near the top with the name or trademark of the manufacturer and the length of the rod in feet.

### 2.2 GROUND WIRES

Ground wires must be in accordance with Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

Ground and bond wires for substations, main panels and distribution points, and ground rod connections must be (b) (7)(E) conforming to (b) (7)(E), with (b) (7)(E) conductivity. Wire size must be in accordance with the grounding requirements of (b) (7)(E).

Ground wires for equipment receptacles for noncurrent carrying hardware, installed in conduit must be (b) (7)(E), in accordance with (b) (7)(E), with green insulation. Note wire size.

### 2.3 CONNECTORS AND FASTENERS

Grounding and bonding fasteners and connectors must conform to the requirements of (b) (7)(E), and Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

Grounding and bonding fasteners must be (b) (7)(E).

Bonding straps and jumpers must be (b) (7)(E) and have a cross-sectional area of not less than No. (b) (7)(E).

## PART 3 EXECUTION

### 3.1 BONDING AND GROUNDING

Bonding and grounding requirements must be in accordance with (b) (7)(E).

### 3.2 GROUNDING ELECTRODES

Grounding electrodes must include ground rods installed expressly for grounding systems.

Minimum ground rod section must be (b) (7)(E). Thread sections together and (b) (7)(E).

### 3.3 EQUIPMENT GROUNDING

In addition to the green colored equipment grounding conductor required in each raceway and sized in accordance with Table 250.122 of the NEC, each panelboard/ switchboard enclosure, transformer housing, motor housing, disconnect, starter, and other electrical equipment, addressed under this contract, must be bonded to the grounding system with a (b) (7)(E).

(b) (7)(E)

(b) (7)(E)

### 3.4 GROUNDING CONNECTIONS

Ground connections must be bonded connections in accordance with paragraph entitled, "Bonding," of this section.

(b) (7)(E)

(b) (7)(E) in accessible locations. Connections to steel building columns in accessible locations must be (b) (7)(E).

Clean, grease, and remove foreign matter from ground connection surfaces. Do not penetrate clad material in the cleaning process. Make connection between like metals where possible. Where dissimilar metals are welded, brazed, or clamped, follow the weld kit manufacturer's instructions.

Connections between dissimilar metals must not produce galvanic action in accordance with (b) (7)(E).

### 3.5 BONDING

#### 3.5.1 Type of Bonds

Accomplish bonding of metal surfaces by welding.

##### 3.5.1.1 Welding

Welding must be by the (b) (7)(E). Within the welding procedure, include the proper mold and powder charge and conform to the manufacturer's recommendations.

Welding processes must be of the (b) (7)(E) that will make a connection without corroding or loosening. Process must join all strands and not cause the parts to be damaged or weakened. Completed connection or joint must be equal or larger in size than the conductors joined and have the same current-carrying capacity as the largest conductor. Paint buried ground connections with a bitumastic paint.

### 3.5.2 Cleaning of Bonding Surfaces

Thoroughly clean surfaces that comprise the bond before joining. Apply an appropriate abrasive with gentle and uniform pressure to ensure a smooth and uniform surface. Do not remove excessive metal from the surface. Clean clad metals in such a manner that the cladding material is not penetrated by the cleaning process. Then clean bare metal with an appropriate solvent to remove any grease, oil, dirt, corrosion preventives, and other contaminants. Bond to the cleaned area must be made within one hour after cleaning. Seal joint and refinish the exposed surfaces within two hours of exposure to prevent oxidation. When additional time is required, apply a corrosion preventive compound until the area can be refinished.

### 3.5.3 Bonding Straps and Jumpers

Install jumpers such that the vibration by the shock-mounted device will not change its electrical characteristics.

(b) (7)(E) for outdoor locations unless a disconnect type of connection is required. When a disconnect is required, use (b) (7)(E)

Bond straps directly to the basic structure and do not penetrate any adjacent parts. Install straps in an area that is accessible for maintenance.

Use single straps for the bonds and install such that they will not restrict movement of structural members. Do not connect two or more straps in series.

Install straps such that they will not weaken structural members to which they are attached.

### 3.5.4 Equipment and Enclosure Bonding

Each metallic enclosure and all electrical equipment must be bonded to ground. At least one (b) (7)(E) connection must be made from the system ground point to one or more enclosures in the area such that all enclosures and equipment provide a low-impedance path to ground when properly bonded together.

### 3.5.5 Bonding of Conduit and Raceway Systems

Bond all metal conduit, fittings, junction boxes, outlet boxes, armored and metal sheathed cable, and other raceways. Take care to ensure adequate electrical contact at the joints and terminations.

#### 3.5.5.1 Rigid Metal Conduit and Terminations

Threaded connections must be wrench-tight and there must be no exposed threads. Ream all ends of the conduit to remove burrs and rough edges. Conduits entering boxes and enclosures must be bonded to the box with locknuts and grounding-type bushings. Locknuts that gouge into the metal box when tightened are not acceptable.

Conduit systems that are interrupted by PVC dielectric links must be bonded separately on either side of the link. Dielectric link must not be jumpered.

#### 3.5.5.2 Flexible Metal Conduit

Flexible conduit must have (b) (7)(E).

#### 3.5.6 Cable Tray Bonding

Bond cable tray sections together. Cable tray sections in tandem assembly must be considered as having electrical continuity when these sections are bonded with the appropriate bolts. Install bond straps across expansion joints. Bond cable trays to the building ground system.

#### 3.5.7 Protection of Finished Bonds

Protect finished bonds by painting to match the original finish after the bond is made.

### 3.6 FIELD TESTS

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

Perform the following tests in the presence of the Contracting Officer.

#### 3.6.1 Bond Resistance Test

Resistance of any bond connection must not exceed (b) (7)(E). Rework bonds that exceed this resistance at no additional cost to the Government.

#### 3.6.2 Ground Resistance Tests

Test Grounding systems for ground resistance. Total resistance from any point on the ground network to the building counterpoise must not exceed (b) (7)(E).

Ground resistance and counterpoise tests must be made during dry weather, and no sooner than 48 hours after rainfall. Conduct tests using the ratio method that measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Perform measurements in accordance with (b) (7)(E).

Indicating instrument must be self-contained and include a direct-current generator, synchronized current and potential reversers, crossed-current and potential coils, direct-reading ohmmeter, series resistors, and range-selector switch. Calibrate direct-reading ohmmeter for ranges of (b) (7)(E).

Place auxiliary grounding electrodes in accordance with instrument manufacturer's recommendations but not less than (b) (7)(E) apart, in accordance with (b) (7)(E).

#### 3.6.3 Ground Isolation Test

Test ground systems for isolation from other ground systems.

#### 3.6.4 Continuity Isolation Test

Perform continuity test on all power receptacles to ensure that the ground terminals are properly grounded to the facility ground system.

-- End of Section --



SECTION 31 00 00

EARTHWORK

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

(b) (7) (E)

U.S. ARMY CORPS OF ENGINEERS (USACE)

(b) (7)(E)

## 1.2 DEFINITIONS

### 1.2.1 Satisfactory Materials

Satisfactory materials comprise any materials classified by (b) (7)(E)

Satisfactory materials for grading comprise stones less than 8 inches, except for fill material for pavements and railroads which comprise stones less than 3 inches in any dimension.

### 1.2.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. Notify the Contracting Officer when encountering any contaminated materials.

### 1.2.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in (b) (7)(E). Materials classified as (b) (7)(E) and (b) (7)(E) will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with (b) (7)(E).

### 1.2.4 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in (b) (7)(E) abbreviated as a percent of laboratory maximum density. Since (b) (7)(E) applies only to (b) (7)(E) in accordance with (b) (7)(E) and corrected with (b) (7)(E). To maintain the same percentage of coarse material, use the "remove and replace" procedure as described in NOTE 8 of Paragraph 7.2 in (b) (7)(E).

### 1.2.5 Topsoil

Material suitable for topsoil is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of trash, debris, stumps, rocks larger than one inch diameter, toxic substances, and

other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7. Top soil may be taken from on-site materials that fit the above description. Top soil may also have woody or organic material to a size that does not obstruct grading or placement of the high performance turf reinforcing mat.

#### 1.2.6 Hard/Unyielding Materials

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than 8 inches in any dimension. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

#### 1.2.7 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

#### 1.2.8 Unstable Material

Unstable material are too wet to properly support the utility pipe, conduit, or appurtenant structure.

#### 1.2.9 Engineered Fill

Engineered fill shall be free of vegetation and debris, and contain no rocks or lumps larger than 3 inches nominal diameter. Engineered fill shall meet the following gradation requirements when tested in accordance with (b) (7)(E). The soils shall possess a plasticity index of (b) (7)(E)

Screen Size (Square Opening)	Percent Passing By Weight
(b) (7)(E)	(b) (7)(E)

#### 1.2.10 Structure Backfill

See local Department of Transportation Standard Specifications, current edition, for structure backfill requirements.

#### 1.2.11 Slurry

Slurry shall consist of engineered fill combined with water and one or two sacks of cement per cubic yard of fill as called for in the project plans or specifications.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD -02 Shop Drawings

Shoring; G

SD -05 Design Data

One Sack Slurry Mix Design; G

Two Sack Slurry Mix Design; G

SD-06 Test Reports

Testing

Borrow Site Testing

Within 24 hours of conclusion of physical tests, a PDF of test results shall be submitted to the Contracting Officer, including calibration curves and results of calibration tests. Results of testing at the borrow site.

SD-07 Certificates

Engineered Fill

Top Soil

Testing

Qualifications of the Corps validated commercial testing laboratory or the Contractor's validated testing facilities.

#### 1.4 SUBSURFACE DATA

Subsurface soil boring logs are provided for the Contractor's information only. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

### PART 2 PRODUCTS

#### 2.1 REQUIREMENTS FOR OFFSITE SOILS

Test offsite soils brought in for use as backfill for Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and full Toxicity Characteristic Leaching Procedure (TCLP) including ignitability, corrosivity and reactivity. Backfill shall contain a maximum of 100 parts per million (ppm) of total petroleum hydrocarbons (TPH) and a maximum of 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall pass the TCPL test. Determine TPH concentrations by using EPA 600/4-79/020 Method 418.1. Determine BTEX concentrations by using EPA SW-846.3-3 Method 5030/8020. Perform TCLP in accordance with EPA SW-846.3-3 Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Do not bring material onsite until tests have been approved by the Contracting Officer.

#### 2.2 MATERIAL FOR RIP-RAP

Provide grout, filter fabric and rock conforming to these requirements for construction indicated.

### 2.2.1 Grout

Provide durable grout composed of (b) (7)(E) to produce a workable mixture, and an amount of admixture which will entrain sufficient air, as determined by the Contracting Officer. Mix grout in a concrete mixer. Allow a sufficient mixing time to produce a mixture having a consistency permitting gravity flow into the interstices of the rip-rap with limited spading and brooming. Consolidate grout into place to provide a dense stone and mortar layer with all voids and interstices filled. After grout has been placed, the rocks shall be thoroughly brushed so their top surfaces are exposed.

### 2.2.2 Rock

Provide angular rock fragments sufficiently durable to ensure permanence in the structure and the environment in which it is to be used. Use rock fragments free from cracks, seams, and other defects that would increase the risk of deterioration from natural causes. Provide rock with a minimum specific gravity of 2.50. Do not permit the inclusion of more than trace 1 percent quantities of dirt, sand, clay, and rock fines. See the plans for the specified riprap classification (D50).

Grading % Passing	Stone Size (inches) by Rip-rap Classification (D50)	
	(b) (7)(E)	(b) (7)(E)
(b) (7)(E)		

### 2.2.3 Filter Fabric

See Section 31 05 19, Geotextile (Filter Fabric).

## 2.3 PIPEBEDDING MATERIAL

Pipe bedding and backfill material shall be #57 course stone, approved equal, when tested in accordance with (b) (7)(E). Pipe bedding and backfill shall be placed as shown in the plans and details.

## PART 3 EXECUTION

### 3.1 STRIPPING OF TOPSOIL

Where indicated or directed, strip topsoil to a depth of 2 inches. Spread topsoil on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inch in diameter, and other materials that would interfere with planting and maintenance operations. Remove from the site any surplus of topsoil from excavations and gradings.

### 3.2 GENERAL EXCAVATION

Excavate to contours, elevation, and dimensions indicated. Reuse excavated materials that meet the specified requirements for the material type required at the intended location. Keep excavations free from water. Excavate soil disturbed or weakened by Contractor's operations, soils softened or made

unsuitable for subsequent construction due to exposure to weather. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shown shall be removed as directed. Refill with backfill and fill material and compact to 95 percent of (b) (7)(E) maximum density. Unless specified otherwise, refill excavations cut below indicated depth with backfill and fill material and compact to 95 percent of (b) (7)(E) maximum density. Satisfactory material removed below the depths indicated, without specific direction of the Contracting Officer's Representative (COR), shall be replaced with satisfactory materials to the indicated excavation grade. Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done under the direction of COR. Use of CLIN(s) for replacement of unsatisfactory material shall be approved by the COR prior to over-excavation of unsatisfactory material.

### 3.3 DRAINAGE

So that construction operations progress successfully, completely drain construction site during periods of construction to keep soil materials sufficiently dry. The Contractor shall establish/construct storm drainage

features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and/or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils[, prevent erosion and undermining of foundations]. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

### 3.4 SELECTION OF BORROW MATERIAL

Select borrow material to meet the requirements and conditions of the engineered fill or embankment for which it is to be used. Obtain borrow material from excavated materials from the project site or selected by the Contractor or from approved private sources. Unless otherwise provided in the contract, the Contractor is responsible for obtaining the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling from the owners. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, do not obtain borrow within the limits of the project site without prior written approval. Consider necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon related operations to the borrow excavation.

### 3.5 SHORING

The Contractor shall be prepared to use shoring as required to control excavations and grades where soft/unstable soils are encountered or to contain excavation within the limits of the Roosevelt Easement. A Shoring and Sheet piling plan shall be submitted for approval 15 days prior to starting that portion of the work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheet piling of excavations. Finish shoring, including sheet piling, and install as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Remove shoring, bracing, and sheet piling as excavations are backfilled, in a manner to prevent caving.

### 3.6 STOCKPILED MATERIAL

Place stockpiles of satisfactory, unsatisfactory/wasted materials at designated staging areas or within the temporary work easement. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources.

### 3.7 SURFACES TO SUPPORT CONCRETE

#### 3.7.1 General Requirements

Surfaces against which concrete is to be placed shall be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing. Standing water shall be removed prior to placement of concrete. Sub-grade surface shall be sprinkled with water as required to eliminate suction at the time concrete is deposited.

#### 3.7.2 Compaction

Fence foundations, retaining walls, concrete lined channels and low water crossings shall be cast on properly compacted soil. Native soils shall be compacted to at least 95% relative density within 3% of optimum moisture prior to setting rebar or forms. Where the contractor cannot achieve the required densities for native sub-grade, the contractor shall over-excavate 2'-0" and replace with engineered fill or two-sack slurry mix. Place engineered fill in successive horizontal layers of loose material not more than 6-inch in depth. Use of CLIN(s) for replacement of unsatisfactory material shall be approved by the COR prior to over-excavation of unsatisfactory material.

#### 3.7.3 Use of Slurry

Where soft sub-grades are encountered due to existing tunnels, where removal of obstructions have caused oversized excavations or where otherwise required the Contractor shall use two-sack slurry to attain the bottom of fence foundation elevation.

#### 3.7.4 Finish Sub-Grade Tolerances

Finished surface of sub-grade or fill under low water crossing and channel slabs shall be not more than (b) (7)(E) elevation indicated.

### 3.8 GROUND SURFACE PREPARATION

#### 3.8.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 6 inch before the fill is started. Plow, step, bench, or break up sloped surfaces so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 6 inch, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 12 inch and compact it as specified for the adjacent fill.

#### 3.8.2 Frozen Material

Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

### 3.9 UTILIZATION OF EXCAVATED MATERIALS

Dispose unsatisfactory materials removing from excavations into designated waste disposal or spoil areas. Use satisfactory material removed from excavations, insofar as practicable, in the construction of engineered fill, embankments, subgrades and for similar purposes. Do not waste any satisfactory excavated material without specific written authorization. Dispose of satisfactory material, authorized to be wasted, in designated areas approved for surplus material storage or designated waste areas as directed. Clear and grub newly designated waste areas on Government-controlled land before disposal of waste material thereon. Stockpile and use coarse rock from excavations for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. Do not dispose excavated material to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

### 3.10 BACKFILLING AND COMPACTION

Place engineered fill adjacent to any and all types of structures and compact to 90% relative density and to within 3% of optimum moisture content. Prepare ground surface on which backfill is to be placed as specified in paragraph GROUND SURFACE PREPARATION. Place engineered fill in successive horizontal layers of loose material not more than 6 inch in depth. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. The Contractor shall be permitted to use one-sack slurry for backfill of structures where compaction of engineered fill is not practical or possible due to tight working conditions.

### 3.11 EMBANKMENTS

Construct earth embankments from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 3 inches. Place the material in successive horizontal layers of loose material not more than 8 inch in depth. Spread each layer uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, plow, disk, or otherwise break up each layer; moisten or aerate as necessary; thoroughly mix; and compact to at least 90% relative density and within 3% of optimum moisture condition. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements are identical with those requirements specified in paragraph SUBGRADE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

### 3.12 ROADWAY SUBGRADE PREPARATION

#### 3.12.1 Proof Rolling

Finish proof rolling on an exposed roadway subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. After stripping, proof roll the existing subgrade with six passes of a 15 ton, pneumatic-tired roller. Operate the roller in a systematic manner to ensure the number of passes over all areas, and at speeds between 2-1/2 to 3-1/2 mph. When proof rolling, provide one-half of the passes made with the roller in a direction perpendicular to the other passes. Notify the Contracting Officer a minimum of 3 days prior to proof



rolling. Perform proof rolling in the presence of the Contracting Officer. Undercut rutting or pumping of material as directed by the Contracting Officer and replace with fill and backfill material.

#### 3.12.2 Roadway Construction

Shape roadway subgrade to line, grade, and cross section, and compact as specified. Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Excavate rock encountered in the cut section to a depth of 6 inch below finished grade for the subgrade. Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line, grade, and cross section and compact as specified. After rolling, do not show deviations for the surface of the subgrade for roadways greater than ½ inch when tested with a 12-foot straightedge applied both parallel and at right angles to the centerline of the area.

#### 3.12.3 Compaction

Finish compaction by sheepfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Compact each layer of the embankment to at least 95 percent of laboratory maximum density.

### 3.13 EMBANKMENT SUBGRADE CONSTRUCTION

Compact subgrade for embankments to at least 90% relative density and within 3% of optimum moisture condition.

### 3.14 PLACEMENT OF PIPE BEDDING MATERIAL

Placement of pipe bedding material shall conform to the details and notes provided in the construction plans.

### 3.15 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Finish roadside ditches in a manner that will result in effective drainage. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

#### 3.15.1 Subgrade and Embankments

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. The Contractor is responsible for protecting and maintaining the finished subgrade in a satisfactory condition until the aggregate surface course is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay aggregate base course until the subgrade has been checked and approved, and in no case place aggregate surface course on a muddy, spongy, or frozen subgrade.

#### 3.15.2 Grading Around Structures

Construct areas within 5 feet outside of each structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

### 3.16 PLACING TOPSOIL

Prepare the compacted subgrade soil to a 2 inch depth for bonding of topsoil with subsoil. Spread topsoil evenly to a thickness of 2 inch and grade to the elevations and slopes shown. Do not spread topsoil when frozen or excessively wet or dry. Obtain material required for topsoil in excess of that produced by excavation within the grading limits from offsite areas.

### 3.17 (b) (7)(E)

(b) (7)(E)

### 3.18 TESTING

Perform testing by a Corps validated commercial testing laboratory or the Contractor's validated testing facility. If the Contractor elects to establish testing facilities, do not permit work requiring testing until the Contractor's facilities have been inspected, Corps validated and approved by the Contracting Officer. Determine field in-place density in accordance with (b) (7)(E). When (b) (7)(E) is used, check the calibration curves and adjust using only the sand cone method as described in (b) (7)(E). When test results indicate, as determined by a designated Government representative, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements. Perform tests on recompacted areas to determine conformance with specification requirements. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

#### 3.18.1 Fill and Backfill Material Gradation

One test per 100 cubic yards stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with (b) (7)(E).

#### 3.18.2 In-Place Densities

- a. One test per 1000 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.
- b. One test per 500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

#### 3.18.3 Check Tests on In-Place Densities

If (b) (7)(E) is used, check in-place densities by (b) (7)(E) as follows:

- a. One check test per lift for each 1000 square feet, or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines.
- b. One check test per lift for each 500 square feet, of fill or backfill areas compacted by hand-operated machines.

#### 3.18.4 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of one test per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.

#### 3.18.5 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 100 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

#### 3.18.6 Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.

-- End of Section --

## SECTION 31 05 19

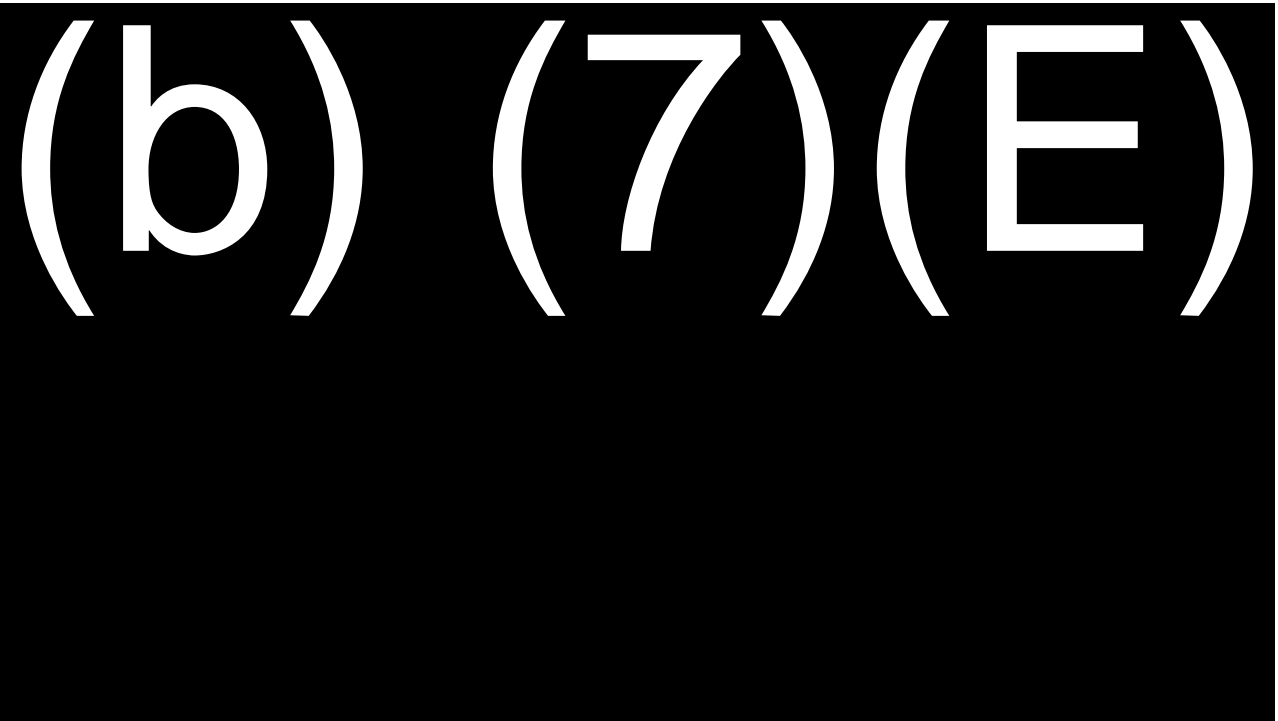
### GEOTEXTILE (FILTER FABRIC)

#### PART 1 GENERAL

##### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)



##### 1.2 PAYMENT

Payment for Geotextiles, as described herein and in the project plans, will constitute full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the work as part of the lump sum cost for Erosion Control.

##### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Product Technical Specifications, G

## Thread

A minimum of 7 days prior to scheduled use, proposed thread type for sewn seams along with data sheets showing the physical properties of the thread.

## Manufacturing Quality Control Sampling and Testing

A minimum of 7 days prior to scheduled use, manufacturer's quality control manual.

## SD-07 Certificates

## Geotextile

A minimum of 7 days prior to scheduled use, manufacturer's certificate of compliance stating that the geotextile meets the requirements of this section. The certificate of compliance shall be attested to by a person having legal authority to bind the geotextile manufacturer.

### 1.4 DELIVERY, STORAGE AND HANDLING

Delivery, storage, and handling of geotextile shall be in accordance with (b) (7)(E).

#### 1.4.1 Delivery

The Contracting Officer shall be notified a minimum of 24 hours prior to delivery and unloading of geotextile rolls. Rolls shall be packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, rolls shall be immediately rewrapped with the plastic wrapping. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Each roll shall be labeled with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

#### 1.4.2 Storage

Rolls of geotextile shall be protected from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees F, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, rolls shall either be elevated off the ground or placed on a sacrificial sheet of plastic in an area where water will not accumulate.

#### 1.4.3 Handling

Geotextile rolls shall be handled and unloaded with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

## PART 2 PRODUCTS

### 2.1 RAW MATERIALS

#### 2.1.1 Geotextile

Geotextile shall be a (b) (7)(E)

(b) (7)(E)  
 Post-consumer recycled material may also be used. Geotextile shall be  
 (b) (7)(E)  
 . Geotextiles shall meet the requirements specified in Table 1. Where applicable, Table 1 property values represent minimum average roll values (MARV) in the weakest principal direction. Values for apparent opening size (AOS) represent maximum average roll values.

TABLE 1

	TEST METHOD	MARV
MECHANICAL		
GRAB TENSILE STRENGTH (AT ULTIMATE)	(b) (7)(E)	
ELONGATION (AT ULTIMATE)		
MULLEN BURST STRENGTH		
TRAPEZOIDAL TEAR STRENGTH		
PUNCTURE STRENGTH		
UV RESISTANCE AFTER 500-HOURS		
HYDRAULIC PROPERTIES		
APPARENT OPENING SIZE		
PERMITTIVITY		
FLOW RATE		

#### 2.1.2 Thread

Sewn seams shall be constructed with high-strength polyester, nylon, or other approved thread type. Thread shall have ultraviolet light stability equivalent to the geotextile and the color shall contrast with the geotextile.

#### 2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer shall be responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. Manufacturing quality control sampling and testing shall be performed in accordance with the manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with (b) (7)(E), Procedure A. Acceptance of geotextile shall be in accordance with (b) (7)(E). Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

### PART 3 EXECUTION

#### 3.1 QUALITY ASSURANCE SAMPLES AND TESTS

##### 3.1.1 Quality Assurance Samples

The Contractor shall provide assistance to the Contracting Officer in the collection of quality assurance samples. Samples shall be collected upon delivery to the site for quality assurance testing [at the request of the Contracting Officer. In accordance with (b) (7)(E) Lot size for quality assurance sampling shall be considered to be the shipment quantity of the product or a truckload of the product, whichever is smaller. The unit size shall be considered one roll of geotextile. Samples shall be identified with a waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. The date and a unique sample number shall also be noted on the sample. The outer

layer of the geotextile roll shall be discarded prior to sampling a roll. Samples shall then be collected by cutting the full-width of the geotextile sheet a minimum of 3 feet long in the machine direction. Rolls which are sampled shall be immediately resealed in their protective covering.

### 3.1.2 Quality Assurance Tests

The Contractor shall provide quality assurance samples to an Independent Laboratory. Samples will be tested to verify that geotextile meets the requirements specified in Table 1. Test method (b) (7)(E) shall not be performed on the collected samples. Geotextile product acceptance shall be based on (b) (7)(E). Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

## 3.2 INSTALLATION

### 3.2.1 Subgrade Preparation

The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction requirements shall be in accordance with Section 31 00 00.

### 3.2.2 Placement

The Contractor shall notify the Contracting Officer a minimum of 24 hours prior to installation of geotextile. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds, and wrinkles. On slopes steeper than 10 horizontal on 1 vertical, the geotextile shall be laid with the machine direction of the fabric parallel to the slope direction.

## 3.3 SEAMS

### 3.3.1 Overlap Seams

Geotextile panels shall be continuously overlapped a minimum of (b) (7)(E) at all longitudinal and transverse joints. Where seams must be oriented across the slope, the upper panel shall be lapped over the lower panel. If approved, sewn seams may be used instead of overlapped seams.

### 3.3.2 Sewn Seams

Factory and field seams shall be continuously sewn on all slopes (b) (7)(E). The stitch type used shall be a 401 locking chain stitch or as recommended by the manufacturer. For field and factory seams which are sewn, the Contractor shall provide at least a 2-meter sample of sewn seam before the geotextile is installed. For seams that are field sewn, the seams shall be sewn using the same equipment and procedures as will be used for the production seams. If seams are sewn in both the machine and cross machine direction, samples of seams from both directions shall be provided. Seam strength shall meet the minimum requirements specified in Table 1. The thread at the end of each seam run shall be tied off to prevent unraveling. Skipped stitches or discontinuities shall be sewn with an extra line of stitching with a minimum of (b) (7)(E).

## 3.4 PROTECTION

The geotextile shall be protected during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Adequate ballast (e.g. sand bags) shall be used to prevent uplift by wind. The geotextile shall not be left uncovered for more than 14 days after installation.

### 3.5 REPAIRS

Torn or damaged geotextile shall be repaired. Clogged areas of geotextile shall be removed. Repairs shall be performed by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a minimum of (b) (7)(E) beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Geotextile rolls which cannot be repaired shall be removed and replaced. Repairs shall be performed at no additional cost to the Government

### 3.6 PENETRATIONS

Engineered penetrations of the geotextile shall be constructed by methods recommended by the geotextile manufacturer.

### 3.7 COVERING

Geotextile shall not be covered prior to inspection and approval by the Contracting Officer. Riprap shall be placed in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On side slopes, riprap shall be placed from the bottom of the slope upward. Riprap shall not be dropped onto the geotextile from a height greater than 3 feet. No equipment shall be operated directly on top of the geotextile without approval of the Contracting Officer. Equipment with ground pressures less than 7 psi shall be used to place the first lift over the geotextile. A minimum of 12 inches of soil shall be maintained between full-scale construction equipment and the geotextile. Cover soil material type, compaction, and testing requirements are described in Section 03 30 00. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

-- End of Section --



SECTION 31 05 19

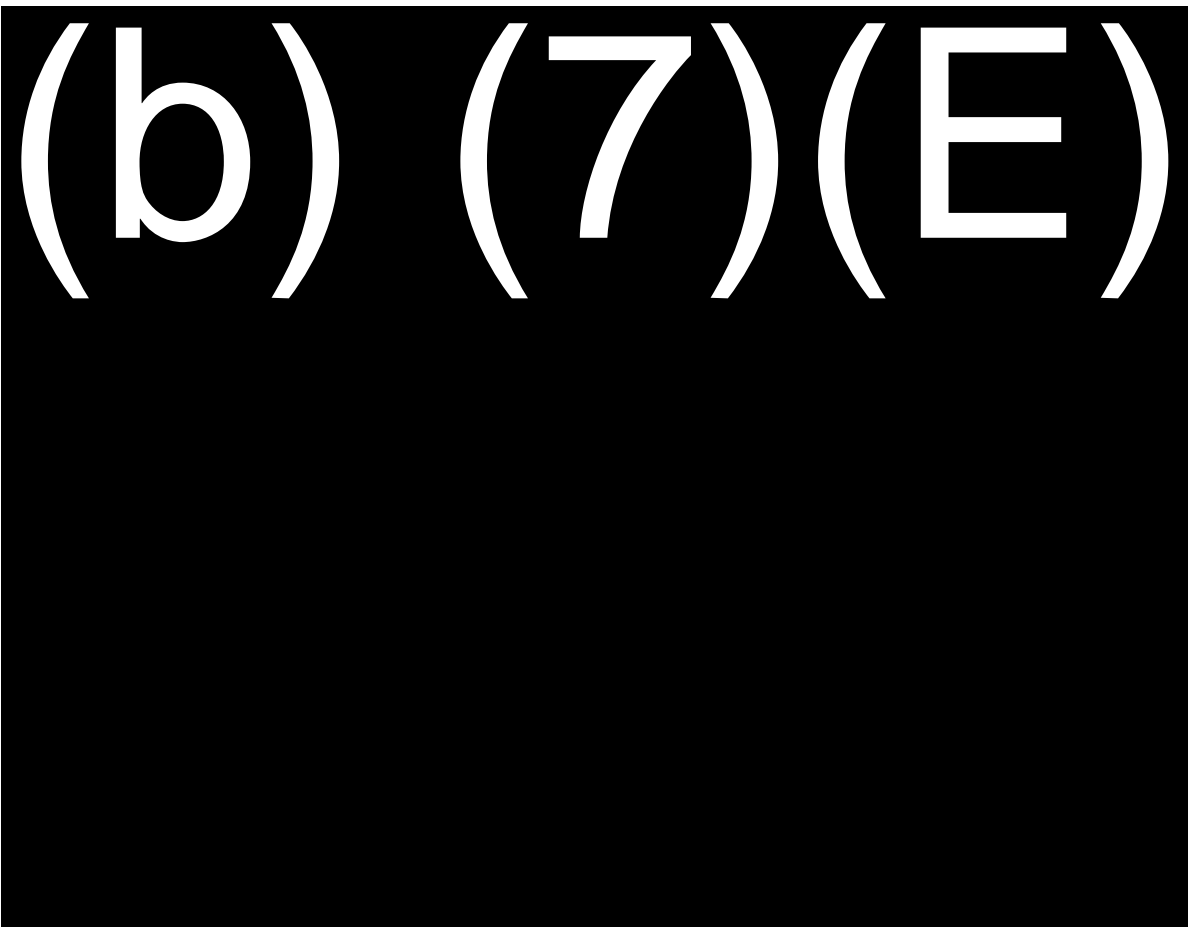
HIGH PERFORMANCE TURF REINFORCEMENT MAT (HPTRM)

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)



1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G

Layout plan along with anchorage, splice, and joint details. Sequencing and construction procedures shall also be included. Proposed layout shall be provided a minimum of 10 working days prior to placement.

#### SD-03 Product Data

Product Technical Specifications, G  
Manufacturing Quality Control Sampling and Testing

#### SD-07 Certificates

High Performance Turf Reinforcement Mat

A minimum of 7 days prior to scheduled use, manufacturer's certificate of compliance stating that the HPTRM meets the requirements of this section. The certificate of compliance shall be attested to by a person having legal authority to bind the HPTRM manufacturer.

#### SD-08 Manufacturer's Instructions

Installation Recommendations; G

### 1.4 DELIVERY, STORAGE AND HANDLING

Delivery, storage, and handling of Turf Reinforcement Mat shall be in accordance with (b) (7)(E)

#### 1.4.1 Delivery

The Contracting Officer shall be notified a minimum of 24 hours prior to delivery and unloading of PPTRM rolls. Rolls shall be packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, rolls shall be immediately rewrapped with the plastic wrapping. HPTRM or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Each roll shall be labeled with the manufacturer's name, HPTRM type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

#### 1.4.2 Storage

Rolls of HPTRM shall be protected from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees F, or any other environmental condition that may damage the physical properties of the HPTRM. To protect HPTRM from becoming saturated, rolls shall either be elevated off the ground or placed on a sacrificial sheet of plastic in an area where water will not accumulate.

#### 1.4.3 Handling

HPTRM rolls shall be handled and unloaded with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

## PART 2 PRODUCTS

### 2.1 RAW MATERIALS

#### 2.1.1 Turf Reinforcement Mat

HPTRM shall be (b) (7)(E)

Post-consumer recycled material may also be used. HPTRM shall be (b) (7)(E)

HPTRM shall meet the requirements specified in Table 1. Where applicable, Table 1 property values represent minimum average roll values (MARV) in the weakest principal direction.

TABLE 1

	TEST METHOD	MARV
PHYSICAL	(b) (7)(E)	
MASS/UNIT AREA		
THICKNESS		
LIGHT PENETRATION (% PASSING)		
COLOR		
MECHANICAL		
TENSILE STRENGTH (GRAB)		
ELONGATION		
REILIENCY		
FLEXIBILITY		
ENDURANCE		
UV RESISTANCE @ 6000 HOURS		

#### 2.1.2 Thread

Sewn seams shall be constructed with high-strength polyester, nylon, or other approved thread type. Thread shall have ultraviolet light stability equivalent to the HPTRM.

### 2.2 ANCHORS

HPTRM anchor shall be (b) (7)(E)

See the plans for proposed density of pin placement. However, the Contractor shall coordinate with the product vendor technical representative regarding the density of pin placement.

#### 2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer shall be responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. Manufacturing quality control sampling and testing shall be performed in accordance with the manufacturer's

approved quality control manual. As a minimum, HPTRM shall be randomly sampled for testing in accordance with (b) (7)(E). Acceptance of HPTRM shall be in accordance with (b) (7)(E). Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

## PART 3 EXECUTION

### 3.1 QUALITY ASSURANCE SAMPLES AND TESTS

#### 3.1.1 Quality Assurance Samples

The Contractor shall provide assistance to the Contracting Officer in the collection of quality assurance samples. Samples shall be collected upon delivery to the site for quality assurance testing [at the request of the Contracting Officer. In accordance with (b) (7)(E), Procedure B. Lot size for quality assurance sampling shall be considered to be the shipment quantity of the product or a truckload of the product, whichever is smaller. The unit size shall be considered one roll of geotextile. Samples shall be identified with a waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. The date and a unique sample number shall also be noted on the sample. The outer layer of the HPTRM roll shall be discarded prior to sampling a roll. Samples shall then be collected by cutting the full-width of the HPTRM sheet a minimum of 3 feet long in the machine direction. Rolls which are sampled shall be immediately resealed in their protective covering.

#### 3.1.2 Quality Assurance Tests

The Contractor shall provide quality assurance samples to an Independent Laboratory. Samples will be tested to verify that HPTRM meets the requirements specified in Table 1. Test method (b) (7)(E) shall not be performed on the collected samples. HPTRM product acceptance shall be based on (b) (7)(E). Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

### 3.2 INSTALLATION

#### 3.2.1 Subgrade Preparation

The surface underlying the HPTRM shall be smooth and free of ruts or protrusions which could damage the HPTRM. Subgrade materials and compaction requirements shall be in accordance with Section 31 00 00.

#### 3.2.2 Placement

The Contractor shall notify the Contracting Officer a minimum of 24 hours prior to installation of HPTRM. HPTRM rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The HPTRM shall be laid flat and smooth so that it is in direct contact with the subgrade. The HPTRM shall also be free of tensile stresses, folds, and wrinkles. On slopes steeper than 10 horizontal on 1 vertical, the HPTRM shall be laid with the machine direction of the fabric parallel to the slope direction.

### 3.3 SEAMS

#### 3.3.1 Overlap Seams

HPTRM panels shall be continuously overlapped a minimum (b) (7)(E) at all longitudinal and transverse joints. Where seams must be oriented across the slope, the upper panel shall be lapped over the lower panel. If approved, sewn seams may be used instead of overlapped seams.

### 3.3.2 Sewn Seams

Factory and field seams shall be continuously sewn on all slopes steeper than (b) (7)(E). The stitch type used shall be a (b) (7)(E) or as recommended by the manufacturer. For field and factory seams which are sewn, the Contractor shall provide at least a (b) (7)(E) sample of sewn seam before the HPTRM is installed. For seams that are field sewn, the seams shall be sewn using the same equipment and procedures as will be used for the production seams. If seams are sewn in both the machine and cross machine direction, samples of seams from both directions shall be provided. Seam strength shall meet the minimum requirements specified in Table 1. The thread at the end of each seam run shall be tied off to prevent unraveling. Skipped stitches or discontinuities shall be sewn with an extra line of stitching with a minimum (b) (7)(E) of overlap.

### 3.4 PROTECTION

The HPTRM shall be protected during installation from clogging, tears, and other damage. Damaged HPTRM shall be repaired or replaced as directed. Adequate ballast (e.g. sand bags) shall be used to prevent uplift by wind. The HPTRM shall not be left uncovered for more than 14 days after installation.

### 3.5 REPAIRS

Torn or damaged HPTRM shall be repaired. Clogged areas of HPTRM shall be removed. Repairs shall be performed by placing a patch of the same type of HPTRM over the damaged area. The patch shall extend a minimum of (b) (7)(E) beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the HPTRM being repaired. HPTRM rolls which cannot be repaired shall be removed and replaced. Repairs shall be performed at no additional cost to the Government.

### 3.6 PENETRATIONS

Engineered penetrations of the HPTRM shall be constructed by methods recommended by the HPTRM manufacturer.

### 3.7 OVERSIGHT

The Contractor shall retain the services of the vendor technical representative. The technical representative shall make one site visit to the project site to observe installation, answer any installation/product questions, and to verify installation procedures have been completed per the approved submittals shown in Paragraph 1.3 of this Section. The Contractor shall schedule the technical representative site visit so to allow for sufficient time to correct any installation concerns addressed by the technical representative. In addition, the Contractor shall appoint a quality control representative to be present at all times during installation. The quality control representative shall have a complete understanding of the approved submittals shown in Paragraph 1.3 of this Section.

-- End of Section --

SECTION 31 05 19

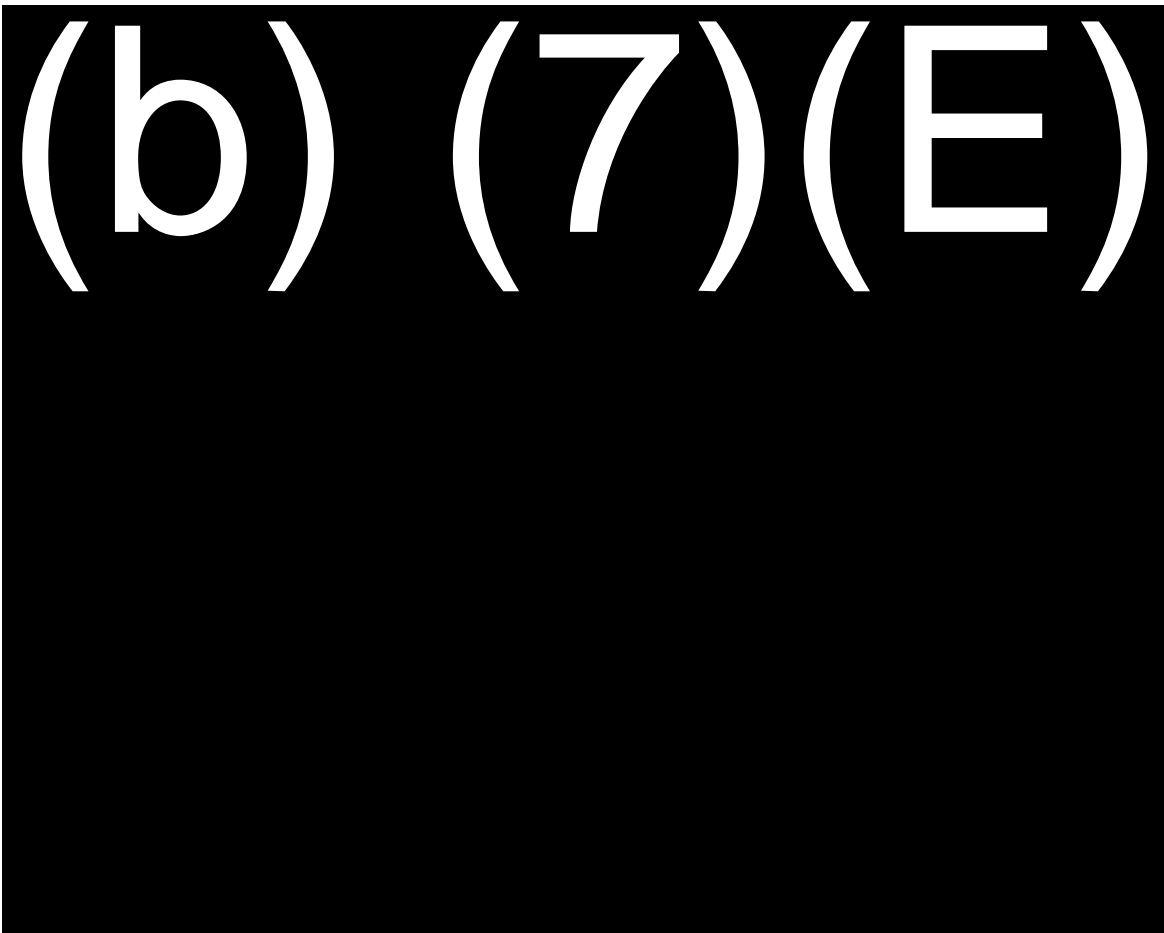
TURF REINFORCEMENT MAT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)



1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

#### Thread

A minimum of 7 days prior to scheduled use, proposed thread type for sewn seams along with data sheets showing the physical properties of the thread.

#### Manufacturing Quality Control Sampling and Testing

A minimum of 7 days prior to scheduled use, manufacturer's quality control manual.

#### SD-o4 Samples

##### Quality Assurance Samples and Tests

Samples for quality assurance testing; 7 days shall be allotted in the schedule to allow for testing.

#### SD-o7 Certificates

##### Turf Reinforcement Mat

A minimum of 7 days prior to scheduled use, manufacturer's certificate of compliance stating that the Turf Reinforcement Mat meets the requirements of this section. For needle punched Turf Reinforcement Mat, the manufacturer shall also certify that the Turf Reinforcement Mat has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers. The certificate of compliance shall be attested to by a person having legal authority to bind the Turf Reinforcement Mat manufacturer.

### 1.5 DELIVERY, STORAGE AND HANDLING

Delivery, storage, and handling of Turf Reinforcement Mat shall be in accordance with (b) (7)(E)

#### 1.5.1 Delivery

The Contracting Officer shall be notified a minimum of 24 hours prior to delivery and unloading of Turf Reinforcement Mat rolls. Rolls shall be packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, rolls shall be immediately rewrapped with the plastic wrapping. Turf Reinforcement Mat or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Each roll shall be labeled with the manufacturer's name, Turf Reinforcement Mat type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

#### 1.5.2 Storage

Rolls of Turf Reinforcement Mat shall be protected from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees F, or any other environmental condition that may damage the physical properties of the Turf Reinforcement Mat. To protect

Turf Reinforcement Mat from becoming saturated, rolls shall either be elevated off the ground or placed on a sacrificial sheet of plastic in an area where water will not accumulate.

### 1.5.3 Handling

Turf Reinforcement Mat rolls shall be handled and unloaded with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

## PART 2 PRODUCTS

### 2.1 RAW MATERIALS

#### 2.1.1 Turf Reinforcement Mat

Turf Reinforcement Mat shall be a (b) (7)(E)

Post-consumer recycled material may also be used. Turf Reinforcement Mat shall be (b) (7)(E)

Turf Reinforcement Mats shall meet the requirements specified in Table 1. Where applicable, Table 1 property values represent minimum average roll values (MARV) in the weakest principal direction. Values for AOS represent maximum average roll values.

TABLE 1

	TEST METHOD	MARV
PHYSICAL		
MASS/UNIT AREA	(b) (7)(E)	
THICKNESS		
LIGHT PENETRATION (% PASSING)		
COLOR	VISUAL	GREEN OR TAN
MECHANICAL		
TENSILE STRENGTH (GRAB)	(b) (7)(E)	
ELONGATION		
REILIENCY		
FLEXIBILITY		
ENDURANCE		
UV RESISTANCE @ 3000 HOURS		

#### 2.1.2 Thread



Sewn seams shall be constructed with high-strength polyester, nylon, or other approved thread type. Thread shall have ultraviolet light stability equivalent to the Turf Reinforcement Mat.

## 2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer shall be responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. Manufacturing quality control sampling and testing shall be performed in accordance with the manufacturer's approved quality control manual. As a minimum, Turf Reinforcement Mat shall be randomly sampled for testing in accordance with (b) (7)(E). Acceptance of Turf Reinforcement Mat shall be in accordance with (b) (7)(E). Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

## PART 3 EXECUTION

### 3.1 QUALITY ASSURANCE SAMPLES AND TESTS

#### 3.1.1 Quality Assurance Samples

The Contractor shall provide assistance to the Contracting Officer in the collection of quality assurance samples. Samples shall be collected upon delivery to the site for quality assurance testing [at the request of the Contracting Officer. In accordance with (b) (7)(E)]. Lot size for quality assurance sampling shall be considered to be the shipment quantity of the product or a truckload of the product, whichever is smaller. The unit size shall be considered one roll of geotextile. Samples shall be identified with a waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. The date and a unique sample number shall also be noted on the sample. The outer layer of the Turf Reinforcement Mat roll shall be discarded prior to sampling a roll. Samples shall then be collected by cutting the full-width of the Turf Reinforcement Mat sheet a minimum of 3 feet long in the machine direction. Rolls which are sampled shall be immediately resealed in their protective covering.

#### 3.1.2 Quality Assurance Tests

The Contractor shall provide quality assurance samples to an Independent Laboratory. Samples will be tested to verify that Turf Reinforcement Mat meets the requirements specified in Table 1. Test method (b) (7)(E) shall not be performed on the collected samples. Turf Reinforcement Mat product acceptance shall be based on (b) (7)(E). Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

### 3.2 INSTALLATION

#### 3.2.1 Subgrade Preparation

The surface underlying the turf reinforcement mat shall be smooth and free of ruts or protrusions which could damage the turf reinforcement mat. Subgrade materials and compaction requirements shall be in accordance with Section 31 00 00.

### 3.2.2 Placement

The turf reinforcement mat shall be installed in accordance with manufacturer's recommendations. The Contractor shall use the appropriate number and size of anchors as recommended by the manufacturer for the slopes which the turf reinforcement mats are placed on. The turf reinforcement mat shall be anchored (b) (7)(E) trench at the top and bottom of the slopes. The Contractor shall notify the Contracting Officer a minimum of 24 hours prior to installation of turf reinforcement mat. Turf Reinforcement Mat rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The turf reinforcement mat shall be laid flat and smooth so that it is in direct contact with the subgrade. The turf reinforcement mat shall also be free of tensile stresses, folds, and wrinkles. On slopes steeper than 10 horizontal on 1 vertical, the turf reinforcement mat shall be laid with the machine direction of the fabric parallel to the slope direction.

### 3.3 SEAMS

#### 3.3.1 Overlap Seams

Turf Reinforcement Mat panels shall be continuously overlapped a minimum of (b) (7)(E) at all longitudinal and transverse joints. Where seams must be oriented across the slope, the upper panel shall be lapped over the lower panel. If approved, sewn seams may be used instead of overlapped seams.

#### 3.3.2 Sewn Seams

Factory and field seams shall be continuously sewn on all slopes steeper than (b) (7)(E) (b) (7)(E). The stitch type used shall be a (b) (7)(E) or as recommended by the manufacturer. For field and factory seams which are sewn, the Contractor shall provide at least a 2-meter sample of sewn seam before the turf reinforcement mat is installed. For seams that are field sewn, the seams shall be sewn using the same equipment and procedures as will be used for the production seams. If seams are sewn in both the machine and cross machine direction, samples of seams from both directions shall be provided. Seam strength shall meet the minimum requirements specified in Table 1. The thread at the end of each seam run shall be tied off to prevent unraveling. Skipped stitches or discontinuities shall be sewn with an extra line of stitching with a (b) (7)(E) of overlap.

### 3.4 PROTECTION

The turf reinforcement mat shall be protected during installation from clogging, tears, and other damage. Damaged turf reinforcement mat shall be repaired or replaced as directed. Adequate ballast (e.g. sand bags) shall be used to prevent uplift by wind. The turf reinforcement mat shall not be left uncovered for more than 14 days after installation.

### 3.5 REPAIRS

Torn or damaged turf reinforcement mat shall be repaired. Clogged areas of turf reinforcement mat shall be removed. Repairs shall be performed by placing a patch of the same type of turf reinforcement mat over the damaged area. The patch shall extend a minimum of (b) (7)(E) beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the turf reinforcement mat being repaired. Turf Reinforcement Mat rolls which cannot be repaired shall be removed and replaced. Repairs shall be performed at no additional cost to the Government.

### 3.6 PENETRATIONS

Engineered penetrations of the turf reinforcement mat shall be constructed by methods recommended by the turf reinforcement mat manufacturer.

### 3.7 COVERING

Turf Reinforcement Mat shall not be covered prior to inspection and approval by the Contracting Officer. Cover soil shall be placed in a manner that prevents soil from entering the turf reinforcement mat overlap zone, prevents tensile stress from being mobilized in the turf reinforcement mat, and prevents wrinkles from folding over onto themselves. On side slopes, soil backfill shall be placed from the bottom of the slope upward. Cover soil shall not be dropped onto the turf reinforcement mat from a height greater than 3 feet. No equipment shall be operated directly on top of the turf reinforcement mat without approval of the Contracting Officer. Equipment with ground pressures less than 7 psi shall be used to place the first lift over the turf reinforcement mat. A minimum of 12 inches of soil shall be maintained between full-scale construction equipment and the turf reinforcement mat. Cover soil material type, compaction, and testing requirements are described in Section 03 30 00. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

-- End of Section --

## SECTION 31 11 00

### CLEARING AND GRUBBING

#### PART 1 GENERAL

##### 1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

##### SD-03 Product Data

##### Nonsaleable Materials; G

Written permission to dispose of such products on private property shall be filed with the Contracting Officer.

##### SD-04 Samples

##### Herbicide

Submit samples in cans with manufacturer's label.

##### 1.2 DELIVERY, STORAGE, AND HANDLING

Deliver materials to, store at the site, and handle in a manner which will maintain the materials in their original manufactured or fabricated condition until ready for use.

#### PART 2 PRODUCTS

##### 2.1 TREE WOUND PAINT

Tree wound paint shall comply with all local, state and federal requirements.

##### 2.2 HERBICIDE

Comply with Federal Insecticide, Fungicide, and Rodenticide Act (Title 7 U.S.C. Section 136) for requirements on Contractor's licensing, certification and record keeping. Contact the command Pest Control Coordinator prior to starting work.

#### PART 3 EXECUTION

##### 3.1 PROTECTION

##### 3.1.1 Roads and Walks

Keep roads and walks free of dirt and debris at all times.

### 3.1.2 Trees, Shrubs, and Existing Facilities

Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require.

### 3.1.3 Utility Lines

Protect existing utility lines that are indicated to remain from damage. Notify the Contracting Officer immediately of damage to or an encounter with an unknown existing utility line. The Contractor shall be responsible for the repairs of damage to existing utility lines that are indicated or made known to the Contractor prior to start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, the Contractor shall notify the Contracting Officer in ample time to minimize interruption of the service.

## 3.2 CLEARING

Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within the areas to be cleared. Clearing shall also include the removal and disposal of minor structures that obtrude, encroach upon, or otherwise obstruct the work. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation as may be indicated or directed to be left standing. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 1-1/2 inches or more in diameter and shall be trimmed of all branches the heights indicated or directed. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 1-1/2 inches in diameter shall be painted with an approved tree-wound paint. Apply herbicide in accordance with the manufacturer's label to the top surface of stumps designated not to be removed.

## 3.3 TREE REMOVAL

Where indicated or directed, trees and stumps that are designated as trees shall be removed from areas outside those areas designated for clearing and grubbing. This work shall include the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING. Trees shall be disposed of as specified in paragraph DISPOSAL OF MATERIALS.

## 3.4 PRUNING

Prune trees designated to be left standing within the cleared areas of dead branches 1 1/2 inches or more in diameter; and trim branches to heights and in a manner as indicated. Neatly cut limbs and branches to be trimmed close to the bole of the tree or main branches. Paint cuts more than 1 1/4 inches in diameter with an approved tree wound paint.

## 3.5 GRUBBING

Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas. Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.

### 3.6 DISPOSAL OF MATERIALS

#### 3.6.1 Nonsaleable Materials

Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations, except for salable timber, shall be disposed of in the designated waste disposal area if any or outside the limits of Government-controlled land at the Contractor's responsibility, except when otherwise directed in writing. Such directive will state the conditions covering the disposal of such products and will also state the areas in which they may be placed.

-- End of Section --

SECTION 31 23 16.13

TRENCHING

PART 1 GENERAL

This work shall consist of trenching, and furnishing and placement of bedding and backfilling material associated with the installation of fence footing, and other work. The work also shall include furnishing, placing and removal of sheeting and shoring (if required), pumping and bailing, and all incidentals necessary to complete the work required by this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

(b) (7) (E)

U.S. ARMY CORPS OF ENGINEERS (USACE)

## 1.2 DEFINITIONS

### 1.2.1 Materials

As defined in Section 31 22 00 and as follows:

#### 1.2.2 Select Granular Material

##### 1.2.2.1 General Requirements

Select granular material consists of materials classified as (b) (7)(E) where indicated. The liquid limit of such material must not exceed (b) (7)(E) when tested in accordance with (b) (7)(E). The plasticity index must not be greater than (b) (7)(E) when tested in accordance with (b) (7)(E), and not more than (b) (7)(E) by weight may be finer than (b) (7)(E) sieve when tested in accordance with (b) (7)(E). Provide a minimum coefficient of permeability of (b) (7)(E) when tested in accordance with (b) (7)(E).

##### 1.2.2 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in (b) (7)(E) abbreviated as a percent of laboratory maximum density. (b) (7)(E)

To maintain the same percentage of coarse material, use the "remove and replace" procedure as described in NOTE 8 of Paragraph 7.2 in (b) (7)(E).

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-01 Preconstruction Submittals

#### Shoring and Shoring Plan; G

Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Drawings shall include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations shall include data and references used.

#### Dewatering Work Plan; G

Submit procedures for accomplishing dewatering work.

### SD-03 Product Data



Utilization of Excavated Materials; G

Rock Excavation

Notification of encountering rock in the project.

Opening of any Excavation or Borrow Pit

Proposed source of borrow material.

Advance notice on the opening of excavation or borrow areas.

Procedure and location for disposal of unused satisfactory material.

Advance notice on shoulder construction for rigid pavements.

SD-06 Test Reports

Borrow Site Testing; G

Select Material Tests

Density Tests

Moisture Content Tests

Copies of lab and field test results within 24 hours of completion of the test.

SD-07 Certificates

Testing

Qualifications of the Corps validated commercial testing laboratory or the Contractor's validated testing facilities.

## 1.6 SUBSURFACE DATA

The Contractor shall perform a geotechnical investigation to determine subsurface conditions and parameters for the work.

## 1.7 BLASTING

Blasting as a means of trench excavation shall not be permitted.

## PART 2 PRODUCTS

### 2.1 REQUIREMENTS FOR ENGINEERED FILL MATERIAL

As defined in contract drawings.

## PART 3 EXECUTION

### 3.1 DEWATERING

Control groundwater flowing toward or into trenching to prevent sloughing of trench slopes and walls, boils, uplift and heave in the trench and to eliminate interference with orderly progress of construction. Take control measures by the time the trenching reaches the water level in order to maintain the integrity of the in situ material. While the trench is open, maintain the water level continuously below the working level. Operate dewatering system continuously until construction work below existing water levels is complete. Submit performance records weekly. Measure and record performance of dewatering system at same time each day by use of observation wells or piezometers installed in conjunction with the dewatering system. Relieve hydrostatic head in previous zones below subgrade elevation in layered soils to prevent uplift.

### 3.2 TRENCHING AND EXCAVATION REQUIREMENTS

Excavate the trench to the indicated line and as shown. Shore trench walls per code and local requirements, cut back to a stable slope, or provide with equivalent means of protection for employees who may be exposed to moving ground or cave in. Excavate trench walls which are cut back to at least the angle of repose of the soil. Give special attention to slopes which may be adversely affected by weather or moisture content.

#### 3.2.1 Bottom Preparation

Grade the bottoms of trenches accurately to provide uniform bearing and support for the fence footing and other construction. Remove stones to avoid intrusion in footing or other interference to other construction.

#### 3.2.2 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for excavating the resulting material and replacing it without additional cost to the Government.

#### 3.2.3 Underground Utilities

The Contractor is responsible for movement of construction machinery and equipment over pipes and utilities during construction. Perform work adjacent to non-Government utilities as indicated in accordance with procedures outlined by utility company. Excavation made with power-driven equipment is not permitted within two feet of known Government-owned utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

#### 3.2.4 Structural Excavation

Ensure that footing subgrades have been inspected and approved by the Contracting Officer prior to concrete placement.

### 3.3 SHORING

### 3.3.1 General Requirements

Submit a Shoring and Sheet piling plan for approval 15 calendar days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheet piling of excavations. Finish shoring, including sheet piling, and install as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Remove shoring, bracing, and sheet piling as excavations are backfilled, in a manner to prevent caving.

### 3.3.2 Geotechnical Engineer

The Contractor is required to hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing preconstruction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer is responsible for updating the excavation, sheet piling and dewatering plans as construction progresses to reflect changing conditions and submit an updated plan if necessary. Submit a monthly written report, informing the Contractor and Contracting Officer of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Contracting Officer is responsible for arranging meetings with the Geotechnical Engineer at any time throughout the contract duration.

## 3.4 BACKFILLING AND COMPACTION

Backfilling shall not begin until construction below finish grade has been approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade. Heavy equipment for spreading and compacting backfill shall not be operated closer to continuous fence footings, or other structural construction than a distance equal to the height of backfill above the bottom of excavation; the area remaining shall be compacted in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall not be placed against continuous fence footings, or other structural construction prior to 7 calendar days after completion of the work. As far as practicable, backfill shall be brought up evenly on each side of the continuous fence footings, or other structural construction and sloped to drain away from the work.

Compact backfill to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials, to prevent wedging action or eccentric loading upon or against the structure.

### 3.4.1 Replacement of Unsuitable or Unstable Material

Replace unsuitable or unstable material removed from the bottom of the trench with select granular material placed in layers not exceeding (b) (7)(E).

## 3.5 TESTING

Perform testing by a Corps validated commercial testing laboratory. Determine field in-place density in accordance with (b) (7)(E) is used, check the calibration curves and adjust using only the sand cone method as described in (b) (7)(E).

Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in (b) (7)(E); check the calibration of both the density and moisture gauges at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. (b) (7)(E), use the Drive Cylinder Method only for soft, fine-grained, cohesive soils. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, remove the

material, replace and recompact to meet specification requirements. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional civil engineer to certify inspections and test results. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

#### 3.5.1 Backfill Material Gradation

One test per 1,000 cubic yards stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with (b) (7)(E).

#### 3.5.2 In-Place Densities

- a. One test per 1,000 linear feet, or fraction thereof, of each lift of backfill areas compacted by other than hand-operated machines.
- b. One test per 500 square feet, or fraction thereof, of each lift backfill areas compacted by hand-operated machines.

#### 3.5.3 Check Tests on In-Place Densities

If (b) (7)(E) is used, check in-place densities by (b) (7)(E) as directed.

#### 3.5.4 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of two tests per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.

#### 3.5.5 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 2,500 cubic yards of backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

-- End of Section --

SECTION 31 63 29

DRILLED CONCRETE PIERS AND SHAFTS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Survey of caisson locations  
Installation Plan

SD-04 Samples

Test caissons

SD-06 Test Reports

Penetration test records

Proof test holes reports

Load test reports

#### SD-07 Certificates

Caisson load tests procedure

#### SD-11 Closeout Submittals

Caisson records

Submit detailed records for each caisson as specified in paragraph entitled "Records."

### 1.3 DELIVERY AND STORAGE

Deliver casings and appurtenant equipment to the job site in an undamaged and ready to place condition. Delivery of concrete shall be in accordance with requirements of Section 03 30 00.00 40.

### 1.4 INSTALLATION PLAN

The Contractor shall provide to the Government for review an approval a detailed installation plan containing the following information:

- 1) List of proposed equipment to be used including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, sampling equipment, tremies or concrete pumps, casing, etc.
- 2) Details of overall construction operation sequence and the sequence of shaft construction.
- 3) Details of shaft excavation methods, including equipment and procedures for checking the dimensions and alignment of each shaft excavation.
- 4) When slurry is required, details of the methods proposed to mix, circulate and desand slurry, and methods proposed to complete the requirements listed herein
- 5) Details of methods to clean the shaft excavation.
- 6) Details of reinforcement placement including support and centralization methods.
- 7) Details of concrete placement.
- 8) Details of casing dimensions, material and splice details
- 9) Details of concrete mix designs and mitigation of possible loss of slump during placement.
- 10) List of work experience in previous similar projects
- 11) Other information shown on the plans or requested by the Government

- 12) Emergency horizontal construction joint method if unforeseen stoppage of work occurs.

The documentation required above shall be submitted to the Government not later than two weeks before work on shafts is to begin. The Government will review the submittal within 10 working days. No drilled shaft work shall be performed until the Contractor's final submittal has been approved by the Government. Such approval will not relieve the Contractor of responsibility for results obtained by the use of the installation plan, or any of its other responsibilities under the contract.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Concrete

Concrete shall conform to the requirements of Section 03 30 00.00 40 Cast-in-Place Concrete except as modified herein.

##### 2.1.1.1 Cement

Where concrete is placed in drilled shaft excavations containing slurry or water, the cement content of the concrete shall be between (b) (7)(E).

##### 2.1.1.2 Aggregate

Maximum aggregate size shall be limited to (b) (7)(E) clear bar spacing (vertical and horizontal), not to exceed (b) (7)(E).

#### 2.1.2 Reinforcing Steel

Reinforcing steel shall conform to the (b) (7)(E).

#### 2.1.3 Casing Steel

Casing shall be steel and may be of unit or sectional construction. The casing shall be of sufficient strength to withstand handling and driving stresses, to withstand the pressure of concrete and the surrounding earth and to prevent seepage of water. Steel shall conform to the requirements of (b) (7)(E).

Should telescoped casing be used, the contractor shall not allow concrete to overfill any interior casing. Spillage must be removed from the annulus, or the shaft shall be declared deficient.

Temporary casing shall be clean, inside and out, prior to placement in the excavation. All casing shall be handled so as to limit distortion to plus or minus two percent of diameter. No side shear capacity will be allowed where temporary casing installed becomes permanent. If approved by the Engineer and if conditions permit, temporary casings may be corrugated and non-watertight.

The Contractor shall be responsible to compensate for loss of frictional capacity in the cased zone if temporary casing is abandoned in the shaft. Such modifications shall be at no additional cost to the Government.

## PART 3 EXECUTION

### 3.1 CONSTRUCTION REQUIREMENTS

#### 3.1.1 Excavation

The Contractor shall perform all excavation required for the drilled shafts through whatever substances encountered, to the dimensions and elevations shown on the plans or ordered by the Engineer. The maximum deviation from plumb shall not be more than one and one half percent. The maximum permissible variation of the design center axis for both the forehole and rebar cage at the top shall be five percent of the shaft diameter, not to exceed three inches from its project plan location. The Contractor shall determine plumbness by plumb lines in dry excavations and Kelly bar position readings at 10-foot intervals in wet excavations. The Contractor shall provide the Engineer with these readings for each drilled shaft constructed to verify plumbness.

If satisfactory material is not encountered at plan elevation, the bottom of any drilled hole may be lowered, at the direction of the Engineer. Alteration of the plan depth will be made to satisfactorily comply with design requirements. Reinforcing steel and concrete shall not be placed in the shaft until this final elevation has been established. Raising of the foundation elevations shall require approval by the Contracting Officer's Representative.

If caving conditions are encountered, no further drilling will be allowed until a construction method is employed that will prevent excessive caving and which is acceptable to the Contracting Officer's Representative. If casing is proposed, the shell shall be clean and shall extend to the top of the drilled shaft excavation. The inside diameter of the casing shall not be less than the specified size of the shaft unless approved by the Contracting Officer's Representative. Then outside diameter of the shaft shall not exceed plan dimension by more than six inches unless use of telescoping casing or surface casing is allowed by the installation plan.

Temporary surface casings may be used to aid shaft alignment and position, and to prevent sloughing of the top of the shaft excavation, if approved by the Contracting Officer's Representative.

If the Contracting Officer's Representative determines that the amount of caving is within acceptable limits and the Contractor elects to drill under the same methods and procedures, the excavation shall be filled with concrete at no additional cost to the Government, regardless of the extent. Any excavation beyond the dimensions shown on the plans where casings are not used shall be filled with concrete at no additional cost to the Government.

If the use of drilling slurry is to be employed, either with or without the use of casing, the Contractor shall use a method of construction which will allow completion of the drilled shaft in a continuous manner without any mixing of concrete and drilling slurry.

Material excavated from the shaft and not incorporated elsewhere on the project shall be disposed of as approved by the Government.

When the plans indicated drilled shafts are to be constructed with embankments, the embankments shall be constructed prior to drilling.

After the completion of the drilled shaft excavation and prior to the placement of the reinforcing steel cage and concrete, all loose material shall be machine cleaned from the shaft. A flight auger or other equipment, approved by the Engineer, shall be used for cleaning dry excavations where slurry or ground water is not present. Where slurry or ground water is present, the excavation shall be cleaned with a clean-out bucket or similar type of equipment, as approved by the Government.



All open excavations shall be covered at the end of each shift in a manner approved by the Government.

### 3.1.2 Drilling Slurry

The Contractor shall provide a specialist experienced in the slurry drilling process to design and monitor the slurry. The specialist shall be present at all times when the slurry method is used, and shall supervise the testing require. Only commercially prepared mineral slurries shall be employed when slurry is used in the drilling process. The slurry shall have both a mineral grain size that will remain in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. The percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. During construction, the level of the mineral slurry in the shaft excavation shall be maintained at a level not less than four feet above the highest expected piezometric pressure head along the depth of the shaft. In the event of a sudden significant loss of slurry to the hole, the construction that foundation shall be stopped until either a method to stop slurry loss or an alternative construction procedure has been approved by the Government.

The mineral slurry shall be premixed thoroughly with clean, fresh water. Adequate time, as prescribe by the mineral manufacturer, shall be allotted for hydration prior to introduction into the shaft excavation. Slurry tanks of adequate capacity shall be required for slurry circulation, storage and treatment. No excavated slurry pits shall be allowed in lieu of slurry tanks. No mixing of slurry shall be allowed in the drilled shaft excavation. Slurry shall not stand for more than four hours in the excavation without agitation. If this is not possible, excavation sidewalls wall be cleaned to remove filter cake and the slurry tested for compliance with the Table 3.1.2A. Slurry density shall be increased by adding (b) (7)(E)

Desanding equipment shall be provided by the contractor as necessary to control slurry sand content within the acceptable values shown in Table 3.1.2A at any point in the bore hole. Desanding will not be required for setting casing. The contractor shall take all steps necessary to prevent the slurry from “setting up” in the shaft. Such methods may include agitation, circulation and/or adjusting the properties of the slurry. The Contractor shall dispose of all slurry off site at an approved disposal site.

Table 3.1.2A			
(b) (7)(E)		or	(b) (7)(E) Fresh Water)
Property Units	Range of Values		Test Method
	At Time of Introduction of Slurry	In Hole at Time of Concreting	
Density: pcf	(b) (7)(E)		Density Balance
Yield Point: Pascals			Rheometer
Or			Rheometer
Viscosity: Seconds/quart			Marsh Cone
pH			pH Paper or pH Meter
Sand Content: % by volume			API Sand Content Kit
* Above 68 degrees F			

3.1.2.1 Slurry Inspection and Testing

The Contractor shall have suitable apparatus available at the site capable of obtaining slurry samples at any depth within the drilled shaft excavation. All equipment required for the tests specified in this section shall be provided by the Contractor, and the tests shall be performed by the Contractor under the observation of the Engineer.

Control tests using suitable apparatus shall be carried out by the Contractor on the mineral slurry to determine density, viscosity or yield point, pH and content. A range of values for those physical properties is shown in Table 2.3.1A.; but, in all cases, at least the minimum value necessary to achieve borehole stability shall be utilized.

Tests to determine density, viscosity or yield point, and pH value shall be done by the Contractor during the shaft excavation to establish a consistent working pattern. A minimum of four sets of tests shall be made during the first eight hours of slurry use. When the results show consistent behavior, the testing frequency may be decreased to one set every four hours of slurry use.

The Contractor shall ensure that heavily contaminated slurry suspension, which could impair the free flow of concrete, has not accumulated in the bottom of the shaft. Prior to placing concrete in any shaft excavation, the Contractor shall take slurry samples using a sampling tool suitable for recovery of slurry samples at any desired elevation in the excavation. Slurry samples shall be extracted from the base of the shaft and at 10 feet up the shaft until samples produce acceptable values for density, viscosity or yield point, pH and sand content.

When any slurry samples are found to be unacceptable, the Contractor shall take whatever action is necessary to bring the mineral slurry within specification requirements. Contract shall not be placed until re-sampling and test results produce acceptable values.

Reports of all tests required above, signed by and authorized representative of the Contractor, shall be furnished to the Government on completion of each drilled shaft.

3.1.3 Integrity Testing

Drilled shaft excavation inspections shall be performed by the Contractor and will be reviewed by the Government. The Contractor shall provide suitable equipment and facilities to perform the required inspections so that the Government may evaluate completed excavations for correct alignment and dimensions.

Reinforcing steel and concrete shall not be placed in the drilled shaft excavation until the Government has made an evaluation and given approval.

Each drilled shaft foundation completed by a wet excavation method shall be inspected by means of a gamma-gamma logging device or by cross-hole sonic logging survey. The Contractor shall furnish and install

(b) (7)(E)  
(b) (7)(E)

The Contractor shall provide the testing equipment, perform the inspection, and furnish test results to the Government.

If the testing indicates the presence of voids, intrusions or zones of unconsolidated concrete in the drilled shaft foundation, or if the Engineer determines that construction defects may have occurred, or if testing cannot be performed because of blockage of the tubes, the Contractor shall core-drill or otherwise determine the extent of any defects in the concrete as approved by the Government. The Contractor shall repair, replace or supplement the defective work in a manner approved by the Government, at no additional cost to the Government.

After all inspections have been completed, all holes and test pipes in all drilled shaft foundations shall be filled with an approved grout.

#### 3.1.4 Reinforcing Steel, Cage Construction and Placement

(b) (7)(E). The reinforcing steel unit shall not be placed until immediately before concreting operations are to be started and shall be placed in accordance with the details shown on the plans.

The (b) (7)(E). Only spacers approved by the Government shall be allowed, but in no case shall (b) (7)(E) (b) (7)(E) tied to the reinforcing steel be allowed.

If the shaft is lengthened and the plans indicate full depth reinforcement, the Government shall be notified to determine if extension of the reinforcement is needed. Then Government will provide details for additional reinforcing if required.

The Contractor shall submit a written request to the Government for approval of any variation for the splices for reinforcing steel specified in the contract documents.

All reinforcing cages shall be fabricated and supported to avoid damage during the lifting and placing. Any temporary bracing and supports shall be removed prior to final placement.

### 3.2 INSTALLATION

#### 3.2.1 General

The Contractor shall begin placement of concrete within 24 hours after the completion of the drilled shaft excavation. All concrete shall be placed in accordance with Section 03 30 00.00 40 and as specified herein. If slurry excavation is used, concrete shall be placed the same day the excavation is completed.

(b) (7)(E) at the time placement begins.

Prior to concrete placement, the Contractor shall make all necessary arrangements to assure the uninterrupted delivery of concrete so that all drilled shaft foundations will be constructed (b) (7)(E). During concrete placement, from start to finish, the rate of rise of the top of concrete in the drilled shaft shall be at least 40 feet per hour.

Tremie downpipes and pump pipes shall be made of steel; no aluminum shall be allowed. The inside diameter of the tremie pipe shall be at least (b) (7)(E). The inside diameter of the pump pipe shall be at least (b) (7)(E).

### 3.2.2 Placement in Dry Excavations

For placement in dry excavations, concrete may be placed by free fall except in cohesionless soils or where other caving conditions exist. The Contractor shall prevent concrete from striking either the reinforcing cage or excavation side walls during free fall. Where free fall cannot be used, concrete shall be placed through a suitable clean downpipe.

Concrete vibration for the full height of the shaft is not necessary to achieve proper consolidation of the concrete. However, the shafts shall be vibrated in the top 10 feet.

For dry shafts, the maximum depth of water in the bottom of the drilled shaft excavation at the time of concrete placement shall be three inches.

### 3.2.3 Placement under Slurry or Water

Concrete shall be placed by tremie methods or by pumping. Care shall be taken to ensure that all the fluid and suspended solids are expelled from the excavation during concrete placement. If concrete is placed by pumping, it shall be in accordance with the requirements of Section 03 30 000.00 40.

The Contractor's installation plan shall demonstrate the procedures used to determine when the tremie pipe is to be raised during concrete placement. The procedure shall assure that the opening of the tremie pipe will be deeper than five feet below the surface of the concrete at all times, and that a void will not be created by lifting the tremie when there is insufficient head of concrete. A rapid raising or lowering of the tremie will not be permitted.

In order to prevent contamination of concrete placed initially, the lower end of the pump or tremie pipe shall be provided with either a valve, sealable cap or plug ("pig"). The discharge end shall be placed at the bottom of the excavation prior to commencement of concrete placement. If a plug is used, it shall be inserted at the top after the pipe has been set in place. Concrete shall then be placed by pushing the plug ahead, separating concrete from the drilling fluid. Only when the tremie pipe is completely filled shall the open end be lifted off the bottom. The first portion of the concrete flow that comes to the top of the shaft shall be displaced out of the shaft excavation until clean, fresh concrete is expelled.

Slurry ejected during concrete placement may be reused provided that it is screened to remove gravel chips other granular materials, and providing the slurry meets acceptance criteria. Slurry to be discarded shall be disposed of in a manner approved by the Government.

Concrete placed under slurry or water shall not be vibrated after the slurry or water and contaminated concrete have been totally expelled from the shaft. If temporary casing is used, the vibration shall occur after the casing has been removed.

### 3.2.4 Casing Removal

During removal of any casing, a sufficient head of (b) (7)(E) shall be maintained. All contaminated concrete shall be removed from the shaft. Temporary casings shall be removed while the concrete slump is a (b) (7)(E) s. The Contractor shall maintain a minimum (b) (7)(E) in the casing as it is being removed. Movement of the casing by exerting downward pressure and tapping to facilitate extraction, or extraction with a vibratory hammer

will be permitted. Casing extraction shall be at a slow, uniform rate with the force in-line with the shaft axis.

Due care shall be exercised to prevent upward movement of the shaft concrete and reinforcing steel during casing extraction. Upward movement beyond one inch, excluding movement due solely to tension on the top anchoring system, may indicate serious concrete separation or necking problems at the bottom of the casing. The contractor shall be responsible for corrective action which may include leaving the casing in place and compensating for the loss of frictional capacity in the resulting cased zone.

### 3.3 RECORDS

Keep complete and accurate records of all caisson installations. Include locations, shaft diameters, top and bottom elevations, depths of test holes, casing dimensions, concrete strength, concrete volume, quantity of rock excavation, excavation condition, dates of excavation and concrete placement, bearing strata description, and subsurface water conditions. Location shall be based on the survey of the registered surveys or engineer provided by the Contractor. All records, including corrective measures, shall be tabulated.

-- End of Section --

SECTION 32 01 13

BITUMINOUS SEAL  
08/08

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT PROCEDURES

Measure the quantities of bituminous material and aggregate used in the accepted work and to be paid for, provided that the measured quantities are not more than 10 percent over the specified application rate. Any amount of bituminous material and aggregate more than 10 percent over the specified application rate for each application will be deducted from the measured quantities except for irregular areas where hand spraying of the bituminous material and hand spreading of the aggregate is necessary.

1.1.1 Bituminous Material Measurement Methods

The amount of bituminous material to be paid for will be measured in (b) (7)(E) or asphalt emulsion].

1.1.2 Aggregate Measurement Methods

The amount of aggregate to be paid for will be measured in [tons] [cubic yards] of dry aggregate. Measurement of the materials shall be by [approved weigh scales] [determining the volume capacity of each vehicle delivering the material to the site of the work or stockpiles].

1.1.3 Payment

The quantities of aggregate and bituminous material, determined as specified above, will be paid for at the respective contract unit prices. Payment will constitute full compensation for all operations necessary to complete the work as specified herein.

1.1.4 Waybills and Delivery Tickets

Do not remove bituminous material from the tank car or storage tank until measurements of the remaining quantity have been taken.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

(b) (7)(E)

(b) (7)(E)



(b) (7)(E)

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

(b) (7)(E)

1.3 SYSTEM DESCRIPTION

1.3.1 Equipment, Plant and Tools

Equipment, plant and tools used in the work are subject to approval and shall be maintained in a satisfactory working condition at all times. Provide equipment which is adequate and has the capability of producing the results specified. Provide calibrated equipment, such as asphalt distributors, scales, batching equipment, spreaders and similar equipment, that has been recalibrated by an approved calibration laboratory within [12] [\_\_\_\_] months prior to commencing work [and every [\_\_\_\_] months thereafter, by such laboratory from the date of recalibration, during the term of the contract]. Submit an equipment list with calibration reports.

1.3.2 Bituminous Distributors

Provide distributors that have pneumatic tires of sufficient size and number to prevent rutting, shoving, or otherwise damaging any part of the pavement structure. Design and equip the distributor to distribute the bituminous material in a uniform double or triple lap at the specified temperature, at readily determined and controlled rates from (b) (7)(E)

, and at variable widths. Include in the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand-held hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. Equip the distributor to circulate and agitate the bituminous material during the heating process.[ Provide distributor with an adjustable, both horizontally and vertically, spray nozzle bar. Make normal width of bar application at least (b) (7)(E), with provisions for lesser or larger width when necessary. Equip distributor with a meter having a dial registering feet of travel/min. Make both dials visible to the distributor driver. Provide a thermometer and well, not in contact with any heating tubes, for accurately indicating temperature of asphalt emulsion.]

1.3.3 Aggregate Spreader

The aggregate-spreading equipment shall be adjustable and capable of uniformly spreading aggregate at the specified rate in a single-pass operation over the surface to be sealed.

1.3.4 Pneumatic-Tired Roller

Provide a pneumatic-tired roller of sufficient size to seat the cover aggregate into the bituminous material without fracturing the aggregate particles. The rollers shall have a total compacting width of not less than 5 feet. The gross weight shall be adjustable within [\_\_\_\_] of compacting width.

1.3.5 Power Brooms and Power Blowers



Provide power brooms and power blowers suitable for cleaning surfaces to [be treated] [which the seal coat is to be applied].

#### 1.3.6 Scales

Use scales of sufficient size and capacity to accommodate all trucks hauling aggregates in the job. All scales shall be tested and approved by an inspector of the state inspection bureau charged with scales inspection within the State in which the project is located. If an official of the inspection bureau is not available, test the scales in accordance with the State specifications in the presence of the Contracting Officer. Keep the necessary number of standard weights on hand at all times for testing the scales.

#### 1.3.7 Weighhouse

Provide a weatherproof weighhouse, constructed in a manner that will afford adequate protection for the recording devices on the scales, of a suitable size with one sliding window facing the scales platform, one end window, and a desk-type area at least 2 feet wide by 6 feet long.

#### 1.3.8 Storage Tanks

Provide tanks capable of heating the bituminous material, under effective and positive control at all times, to the required temperature. Accomplish heating by steam coils, hot oil, or electricity. Affix to the tank an armored thermometer with a range from 100 to 300 degrees F so that the temperature of the bituminous material may be read at all times.

#### 1.3.9 Power Rollers

Provide self-propelled tandem and three-wheel type rollers, weighing not less than 5 tons and suitable for rolling bituminous pavements. The wheels of the rollers shall be equipped with adjustable scrapers. Equip the rollers with water tanks and sprinkling apparatus for keeping the wheels wet in order to prevent adherence of the bituminous material to the wheels.

#### 1.3.10 Single-Pass, Surface-Treatment Machines

Provide machines capable of spraying bituminous material and spreading aggregate in one pass; of distributing the bituminous material uniformly, at even heat, and in controlled amounts; and immediately spreading aggregates uniformly, in controlled amounts, over the surface to be sealed.

### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.][information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-03 Product Data

##### Waybills and Delivery Tickets

Waybills and delivery tickets, during the progress of the work. Before the final statement is allowed, file certified waybills and delivery tickets for all materials used in the work covered by this section.

##### Equipment List

List of equipment used in the project along with calibration reports.

#### SD-04 Samples

##### Bituminous Materials

##### Aggregates

From each source of supply, a one gallon sample of bituminous material and a 50 pound sample of aggregate for each aggregate size.

#### SD-06 Test Reports

##### Tests

Copies of the test results, within 24 hours of the completion of the test. Certified copies of the aggregate test results, not less than [30] [\_\_\_\_] days before the material is required in the work. Certified copies of the bituminous materials test reports indicating compliance with applicable specified requirements, not less than [30] [\_\_\_\_] days before the material is required in the work. A copy of the calibration test results, before the bituminous distributor and aggregate spreader are used on the job.

### 1.5 QUALITY ASSURANCE

Perform sampling and testing using an approved commercial testing laboratory or facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved. The first inspection will be at the expense of the Government. Costs incurred for any subsequent inspection will be charged to the Contractor. Perform tests in sufficient numbers, and at the location and times directed, to ensure that the materials meet specified requirements.

#### 1.5.1 Samples

Take aggregate samples for laboratory tests in accordance with (b) (7)(E). Take samples of bituminous material in accordance with (b) (7)(E).

#### 1.5.2 Aggregates Source

Select sources from which aggregates are to be obtained and notify the Contracting Officer within 15 days after the award of the Contract. Perform tests for the evaluation of aggregates by using an approved commercial laboratory at no expense to the Government. Tests for determining the suitability of aggregate shall include, but not limited to: gradation in accordance with (b) (7)(E), abrasion resistance in accordance with (b) (7)(E), clay lumps and friable particles in accordance with (b) (7)(E), unit weight and voids in accordance with (b) (7)(E), and flat and elongated particles in accordance with (b) (7)(E). The use of an antistripping agent is subject to approval by the Contracting Officer.

#### 1.5.3 Bituminous Material Source

Select sources from which bituminous materials are to be obtained and notify the Contracting Officer within 15 days after the award of the contract.

#### 1.5.4 Equipment Calibration

Furnish all equipment, materials and labor necessary to calibrate the bituminous distributor and the aggregate spreader. Perform all calibrations with the approved job materials and prior to applying the specified coatings to the prepared surface. Perform calibration of the bituminous distributor in accordance with (b) (7)(E). [ Perform work to calibrate tank and measuring devices of the distributor. Perform inspection and calibration at the beginning of the work and at least once a day during construction.]

#### 1.6 ENVIRONMENTAL REQUIREMENTS

Apply the coating when the existing surface is dry, and when the weather is not foggy, rainy, or when the wind velocity will prevent the uniform application of the bitumen [or aggregates]. [Apply the bituminous seal coat only when the atmospheric temperature is above 60 degrees F in the shade and when the pavement surface temperature is above 60 degrees F, unless otherwise directed.]

### PART 2 PRODUCTS

#### 2.1 BITUMINOUS MATERIAL FOR SEAL COAT

Bituminous material shall conform to (b) (7)(E) [grade [\_\_\_\_]] [penetration grade [\_\_\_\_]].

#### 2.2 AGGREGATE FOR SEAL COAT

Provide aggregate consisting of crushed stone, crushed gravel, crushed slag, sand and screenings. The moisture content of the aggregate shall (b) (7)(E) [\_\_\_\_]. Drying may be required, as directed. The aggregate shall conform to the gradation shown in TABLE I. The aggregate gradation shall be allowed the tolerances given in TABLE II.

TABLE I. AGGREGATE GRADATIONS

(Percent by Weight Passing Square-Mesh Sieves)

Sieve Size	Gradation No. 1	Gradation No. 2	Gradation No. 3
_____	_____	_____	_____

(b) (7)(E)

TABLE II. AGGREGATE GRADATION TOLERANCES

Material	Tolerances
_____	_____
(b) (7)(E)	

(b) (7)(E)

#### 2.2.1 Coarse Aggregate

Coarse aggregate shall consist of clean, sound, durable particles meeting the following requirements.

##### 2.2.1.1 Film Retention

The aggregate shall exhibit not less than 95 percent retention of bituminous film.

##### 2.2.1.2 Particle Shapes

The quantity of flat and elongated particles on any sieve shall (b) (7)(E) by weight when determined in accordance with (b) (7)(E). A flat particle is (b) (7)(E)

##### 2.2.1.3 Weight Loss

The percent weight loss shall not exceed 40 after 500 revolutions, as determined in accordance with (b) (7)(E).

##### 2.2.1.4 Friable Particles

The amount of friable particles shall not exceed 0.1 percent of the total weight of aggregate sample when tested in accordance with (b) (7)(E).

##### 2.2.1.5 Crushed Slag

The dry weight of crushed slag shall (b) (7)(E), as determined in accordance with (b) (7)(E).

##### 2.2.1.6 Crushed Aggregate

Crushed aggregate retained on the No. 4 sieve and each coarser sieve shall (b) (7)(E)

#### 2.2.2 Fine Aggregate

Fine aggregate shall consist of clean, sound, durable particles of crushed stone, durable particles of crushed stone, slag, or gravel. The aggregate shall meet its requirements for stripping, abrasion resistance and percent friable particles as specified for coarse aggregate.

#### 2.3 ANTISTRIPPING AGENT

The use of antistripping agent is subject to prior approval by the Contracting Officer.

#### 2.4 WATER

Provide fresh, clean, and potable water.

## PART 3 EXECUTION

### 3.1 PREPARATION OF SURFACE

Repair damaged surface and fill cracks before starting work. Immediately before starting work, remove all loose material, dirt, clay, or other objectionable material from the surface to be treated with power brooms or power blowers, if needed. Paint firmly bonded to the surface that has the chalk removed may remain. Material removed from the surface shall not be mixed with the cover aggregate.

### 3.2 SEAL COAT APPLICATION

#### 3.2.1 Rate

Spread the bituminous material in the quantities shown in TABLE III. The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contractor and approved by the Contracting Officer prior to use.

TABLE III. APPLICATION OF MATERIAL

(Quantities Per Square Yard)

Gradation No.	Bitumen, gallons	Aggregate, pounds

(b) (7)(E)

#### 3.2.2 Temperature

[Asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 centistokes, kinematic. Furnish the temperature viscosity relation to the Contracting Officer.] [Tar application temperature shall be within the following ranges as directed:]

RT-6 ----- 80-150 degrees F

RT-7 ----- 150-225 degrees F

RT-8 ----- 150-225 degrees F

RT-9 ----- 150-225 degrees F

RT-10 ----- 125-250 degrees F

RT-11 ----- 125-250 degrees F.

#### 3.2.3 Application of Bituminous Material

Following the preparation and inspection of the pavement surface, apply the seal coat material at the specified rates. Uniformly apply the bituminous material in a single pass of the distributor and with either a double or triple lap spray over the surface to be sealed. Spread building paper on the surface for a sufficient distance back from the ends of each application so that flow through the spray bar may be started and stopped on the paper and so that all sprays will be operating at the proper pressure on the surface to be sealed. Immediately after the application, remove the building paper. Properly treat with bituminous material spots missed by the distributor. No smoking, fires, or flames, other than the heaters that are a part of the equipment, will be permitted within 25 feet of heating, distributing, and transferring operations of bituminous material other than bituminous emulsions. [If tar is used, a full-face organic vapor-type respirator and protective creams shall be used by personnel exposed to fumes. Protective creams shall not be used as a substitute for cover clothing.]

#### 3.2.4 Aggregate Application Rate

Spread the aggregate in the quantities shown in TABLE III. The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contractor, and approved by the Contracting Officer prior to use. The aggregate weights shown in this table are those of aggregate having a specific gravity of 2.65. If the specific gravity of the aggregate to be used is less than 2.55 or greater than 2.75, make adjustments in the number of pounds of aggregate required per square yard to insure a constant volume of aggregate per square yard of treatment.

#### 3.2.5 Application of Aggregate

Spread the specified quantity of cover aggregate uniformly over the bituminous material. Before the bituminous material is applied, sufficient aggregate to cover the distributor load of bituminous material shall be on trucks at the site of the work. No bituminous material shall be down more than 3 minutes before it is covered with aggregate. Spreading shall be done uniformly with aggregate-spreading equipment. Trucks spreading aggregate shall be operated backwards, covering the bituminous material ahead of the truck wheels. Areas having insufficient cover shall be lightly recovered with additional aggregate by hand during the operations whenever necessary.

#### 3.2.6 Rolling and Brooming

Begin rolling operations immediately following the application of cover aggregate. Perform rolling using pneumatic-tired rollers. Operate the rollers at a speed that will not displace the aggregate. Continue rolling until the aggregate is uniformly distributed and keyed into the bituminous material. All surplus aggregate shall be swept off the surface and removed not less than 24 hours nor more than 4 days after rolling is completed.

### 3.3 FIELD QUALITY CONTROL - SEAL COAT

#### 3.3.1 Tests

Perform field tests in sufficient numbers to assure that the specifications are being met. Testing is the responsibility of the Contractor and shall be performed by an approved commercial laboratory. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type of operation.

##### 3.3.1.1 Gradation

Perform gradation tests in accordance with (b) (7)(E). Perform a minimum of one gradation for every [\_\_\_\_\_] [tons] [<MET>cubic meters</MET> cubic yards] of aggregate to be placed, with a minimum of three gradations for each day's run. When [the source of materials is changed or] deficiencies are found,

the gradation shall be repeated and the material already placed shall be retested to determine the extent of the unacceptable material. Replace all in-place unacceptable material at no additional expense to the Government.

#### 3.3.1.2 Abrasion Resistance

Perform abrasion resistance tests in accordance with (b) (7)(E). Perform one test for every [\_\_\_\_\_] [tons] [cubic yards] of aggregate placed.

#### 3.3.1.3 Stripping

Perform stripping test on aggregate from each source, in accordance with (b) (7)(E), prior to incorporation into the work and when the source is changed.

#### 3.3.2 Bituminous Material Sample

Obtain a sample of the bituminous material used under the supervision of the Contracting Officer. The sample will be retained by the Government.

#### 3.4 TRIAL APPLICATION - SEAL COAT

Prior to applying the seal coat, place a test section at least 100 feet long by 20 feet wide using the approved job materials and roll them in accordance with the specified requirements. Perform tests to determine the application rates of the bitumen and aggregate. If the tests indicate that the seal coat test section does not conform to the specification requirements, make necessary adjustments to the application equipment and to the spreading and rolling procedures, and construct additional test sections for conformance to the specifications. Where test sections do not conform to specification requirements, remove seal coat at no expense to the Government; no separate payment will be made for seal coat materials and labor, either in placement or removal of any test section. Perform quality control sampling and testing during construction as required in paragraph FIELD QUALITY CONTROL above.

#### 3.5 SITE PROTECTION

During applications, protect adjacent buildings, structures, vehicles, manhole covers, inlet grates, and trees to prevent being spattered or marred.

#### 3.6 TRAFFIC CONTROL

Protect freshly placed coatings from damage by traffic. Provide sufficient warning signs and barricades to prevent traffic over freshly treated surfaces. Protect treated areas from traffic for at least [2] [24] hours after final application of coatings, or for such time as necessary to prevent picking up. Immediately prior to opening to traffic, roll the entire treated area with a self-propelled pneumatic-tired roller. Provide warning signs and barricades for proper traffic control, in accordance with (b) (7)(E).

-- End of Section --

SECTION 32 10 00

[PERVIOUS] BITUMINOUS CONCRETE PAVEMENT  
08/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

(b) (7)(E)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

(b) (7)(E)

U.S. GREEN BUILDING COUNCIL (USGBC)



LEED

(2002; R 2005) Leadership in Energy and Environmental  
Design(tm) Green Building Rating System for New  
Construction (LEED-NC)

## 1.2 RELATED SECTIONS

Pervious pavement systems shall use Section 32 11 16.16 SUBBASE COURSE FOR PERVIOUS PAVING, Section 32 11 24 GRADED CRUSHED AGGREGATE BASE COURSE FOR PERVIOUS PAVEMENT, and Section 32 12 10 BITUMINOUS TACK AND PRIME COATS in addition to this section.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-03 Product Data

Precast car stops; (LEED)  
Aggregate; (LEED)  
Asphalt cement; (LEED)

Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

[Local/Regional Materials; (LEED)]

Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.]

[Albedo; (LEED)]

Provide information identifying the reflectance of the pavement.]

### SD-04 Samples

[Field-Constructed Mockup]

Uncompacted mix  
Pavement cores

### SD-06 Test Reports

Trial batch reports  
Mix design  
Asphalt concrete

Density

Thickness

Straightedge test

Submit reports for testing specified under paragraph entitled "Field Quality Control."

#### SD-07 Certificates

Asphalt mix delivery record

Asphalt concrete and material sources

Obtain approval of the Contracting Officer for materials and material sources 2 days prior to the use of such material in the work.

Asphalt concrete

Curbs

Guard (Guide) rails

Median barriers

Traffic signs

Submit certificates, signed by the producer, that paving materials and incidental construction items conform to specification requirements.

### 1.4 QUALITY ASSURANCE

#### 1.4.1 Regulatory Requirements

Provide work and materials in accordance with applicable requirements of SHS [\_\_\_\_]. [Divisions and Sections] [Sections and Paragraphs] [[\_\_\_\_] and [\_\_\_\_]] mentioned herein refer to those specifications. Paragraphs in SHS [\_\_\_\_] entitled ["Quantity and Payment"] ["Method of Measurement" and "Basis of Payment"] ["\_\_\_\_"] shall not apply.

#### 1.4.2 Modification of References

Where term "Engineer" is used in SHS [\_\_\_\_] it shall be construed to mean [Contracting Officer] [Contractor's Quality Control representative]. [Where term "state" is used, it shall mean "Federal Government"].

#### 1.4.3 Mix Delivery Record Data

Record and submit the following information to each load of mix delivered to the job site. Submit within one day after delivery on Government-furnished forms:

a. Truck No:

- b. Time In:
- c. Time Out:
- d. Tonnage and Discharge Temperature:
- e. Mix Type:
- f. Location:
- g. Stations Placed:

#### 1.4.4 Trial Batch

Submit current bituminous design reports for all mix types proposed for use on the project.

#### 1.4.5 Mix Design

Submit results of laboratory tests performed on each mix design. Testing shall have been accomplished not more than one year prior to date of material placement.

#### 1.4.6 Field-Constructed Mockup

[Install minimum 225 square feet to demonstrate typical joints, surface finish, texture, color, permeability, and standard of workmanship. When Contracting Officer determines that mockup does not meet requirements, demolish and remove it from the site and install another until the mockup is accepted. Keep accepted mockup undisturbed during construction as a standard for judging completed paving. Accepted mockup may be incorporated into final work when approved by Contracting Officer.]

### 1.5 SUSTAINABLE DESIGN REQUIREMENTS

#### 1.5.1 Local/Regional Materials

[Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [500][\_\_\_\_\_] mile radius from the project site, if available from a minimum of three sources.][See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local material requirements. Paving materials may be locally available.]

## PART 2 PRODUCTS

### 2.1 ASPHALT CONCRETE

Provide asphalt concrete in accordance with the applicable requirements of the SHS [\_\_\_\_], except where specified otherwise. Recycled asphalt pavement material may be used as permitted by SHS [\_\_\_\_].

#### 2.1.1 Albedo

Installed system shall have a minimum solar reflectance of 0.3.

#### [2.1.2 Permeability

Installed system shall have a minimum permeability rate of [60][\_\_\_\_\_] percent.

## 2.2 SUBBASE

SHS [\_\_\_\_], materials for construction of the subbase shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]].

## 2.3 BASE COURSE

SHS [\_\_\_\_], materials for construction of the base course shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]], [Type [\_\_\_\_]] [Class [\_\_\_\_]].

## 2.4 SURFACE COURSE

SHS [\_\_\_\_], materials for construction of the surface course shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [Type [\_\_\_\_]] [Class [\_\_\_\_]]. [Edge restraints for pervious systems shall be [concrete][\_\_\_\_].]

## 2.5 STRIPING

SHS [\_\_\_\_], materials for paint striping shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]], [[\_\_\_\_], [\_\_\_\_]].

[Paint shall conform to FS TT-P-115, Types I, or II.]

## 2.6 CURBS [AND GUTTERS]

SHS [\_\_\_\_], materials for construction of curbs [and gutters] shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]].

[Concrete is specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.]

## 2.7 GUARD (GUIDE) RAILS

SHS [\_\_\_\_], materials for construction of the guard (guide) rails shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]].

## 2.8 MEDIAN BARRIERS

SHS [\_\_\_\_], materials for construction of the median barriers shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]].

## 2.9 TRAFFIC SIGNS

SHS [\_\_\_\_], provide traffic signs in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]].

## 2.10 PRECAST CAR STOPS

Provide car stops to the profile and size indicated. [Manufacture with (b) (7)(E)]  
[\_\_\_\_].][Manufacture with 100 percent recycled content level of plastic or rubber in accordance with (b) (7)(E)].

## 2.11 COMPOSITION OF MIXTURE REQUIREMENTS

### 2.11.1 Mixture Properties

Gradation of mineral aggregate shall be as specified. Percentage of bituminous material provided in the bituminous mixtures shall be within the limits specified. Mixtures shall have the following physical properties:

<u>Test Property</u>	<u>Values</u>
Stability (b) (7)(E)	(b) (7)(E)
Flow (b) (7)(E)	(b) (7)(E)
Percent Air Voids	(b) (7)(E) for binder course; (b) (7)(E) for wearing course
Percent Voids in Mineral Aggregates	See Table I

TABLE I

#### MINIMUM PERCENT VOIDS IN MINERAL AGGREGATE (VMA)

<u>U.S.A. Standard Sieve Designation</u>	<u>Nominal Maximum Particle Size, Inch</u>	<u>Minimum VMA Percent</u>
--	--	--------------------------------

(b) (7)(E)

### 2.11.2 Aggregate

#### 2.11.2.1 Course Aggregate

[Coarse aggregate shall contain a minimum of [25][\_\_\_\_\_] percent recycled porcelain, concrete, stone, or other recycled material complying with (b) (7)(E).][See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements. Aggregate may contain post-consumer or post-industrial recycled content.]

### 2.11.3 Quantity of Bituminous Material

[Asphalt cement shall contain a minimum of [5][10][\_\_\_\_\_] percent post-consumer recycled content, or a minimum of [20][40][\_\_\_\_\_] percent pre-consumer recycled content.][See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements. Asphalt cement may contain post-consumer or post-industrial recycled content.] Recycling agents shall comply with (b) (7)(E) Hot recycling agents shall comply with (b) (7)(E) (b) (7)(E) Evaluate blends in accordance with (b) (7)(E). Mix asphalt cement with aggregates of corresponding mixes in the following proportions:

## ASPHALT CEMENT PERCENT BY WEIGHT OF TOTAL MIX

Binder Course

Wearing Course

**(b) (7)(E)**

### PART 3 EXECUTION

#### 3.1 PREPARATION

##### 3.1.1 Excavation and Filling

Excavation and filling to establish elevation of subgrade is specified in Section 31 00 00 EARTHWORK.

#### 3.2 CONSTRUCTION

Provide construction in accordance with the applicable requirements of the SHS [\_\_\_\_], except where indicated or specified otherwise. [Install pervious paving system in accordance with manufacturer's recommendations and as indicated.]

##### 3.2.1 Subgrade

SHS [\_\_\_\_], preparation of subgrade shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]], [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]] [Section 31 00 00 EARTHWORK.] Verify compacted subgrade, granular base, or stabilized soil is acceptable and ready to support paving and imposed loads.

##### 3.2.2 Subbase

SHS [\_\_\_\_], methods of construction of the subbase shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]].

##### 3.2.3 Base Course

SHS [\_\_\_\_], methods of construction of the base course shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]].

##### [3.2.4 Edge Restraints

Install edge restraints of pervious systems per the drawings and manufacturer's recommendations.

##### ]3.2.5 Surface Course

SHS [\_\_\_\_], methods of construction of the surface course shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]]. Placement will not be permitted unless the Contractor has a working asphalt thermometer on site.

##### 3.2.6 Striping

SHS [\_\_\_\_], provide paint striping in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]]. Allow bituminous pavement to cure for at least 21 days before paint is applied. Pavement shall be thoroughly clean and entirely free of loose sand, stones, dust, oil, grease, water, and other substances that will be deleterious to the paint or will adversely affect the

adhesion of the paint. Do not apply paint during high wind (over 15 miles per hour) or high humidity (over 70 percent). Apply paint only when ambient temperature is 40 degrees F or above and rising but not more than 95 degrees F. Dimensions and arrangement of striping shall be as indicated. Apply paint to a wet film thickness of 0.015 inch by means of conventional traffic line striping equipment. Traffic shall not be permitted to use the painted areas for a minimum of 30 minutes after painting of lines has been completed.

### 3.2.7 Curbs [and Gutters]

SHS [\_\_\_\_], methods of construction of curbs [and gutters] shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]].

[Provide curbs [and gutters] as indicated. Provide concrete construction as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.]

### 3.2.8 Guard (Guide) Rails

SHS [\_\_\_\_], methods of construction of the guard (guide) rails shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]].

### 3.2.9 Median Barrier

SHS [\_\_\_\_], methods of construction of the median barriers shall be in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]].

### 3.2.10 Traffic Signs

SHS [\_\_\_\_], install traffic signs in accordance with [Division [\_\_\_\_], Section [\_\_\_\_]] [Section [\_\_\_\_], paragraph [\_\_\_\_]] [[\_\_\_\_], [\_\_\_\_]].

### 3.2.11 Precast Car Stops

Provide car stops where indicated. (b) (7)(E)

## 3.3 FIELD QUALITY CONTROL

Sample shall be taken by Contractor as specified herein. Contractor shall replace pavement where sample cores have been removed. Submit [2] [\_\_\_\_] pavement cores when using the in-place nuclear density method.

### 3.3.1 Sample and Core Identification

Place each sample and core in a container and securely seal to prevent loss of material. Tag each sample for identification. Tag shall contain the following information:

- a. Contract No.
- b. Sample No.
- c. Quantity
- d. Date of Sample

- e. Sample Description
- f. Source/Location/Stations Placed/depth below the finish grade
- g. Intended Use
- h. Thicknesses of various lifts placed

### 3.3.2 Testing

#### 3.3.2.1 Bituminous Mix Testing

Take two samples per day per mix type at plant or from truck. Test uncompacted mix for extraction in accordance with (b) (7)(E) and sieve analysis in accordance with (b) (7)(E). Test samples for stability and flow in accordance with (b) (7)(E). When two consecutive tests fail to meet requirements of specifications, cease placement operations and test a new trial batch prior to resumption of placement operations. Submit [2] [ ] per day of each mix type. When two tests on uncompacted mix fail submit new trial batch for approval.

#### 3.3.2.2 Testing of Pavement Course

- a. Density: Determine density of pavement by testing cores obtained from the binder and wearing course in accordance with (b) (7)(E). Take three cores at location designated by Contracting Officer for each [200 tons] [ ], or fraction thereof, of asphalt placed. Deliver cores undisturbed and undamaged to laboratory and provide test results within [48] [ ] hours of each day placement of paving materials.
- b. Thickness: Determine thickness of the binder and wearing course from cores taken for density test.
- c. Straightedge Test: Test compacted surface of binder course and wearing course with a straightedge as work progresses. Apply straightedge parallel with and at right angles to center line after final rolling. Variations in the binder course surface shall not be more than (b) (7)(E) inches from the lower edge of the (b) (7)(E) straightedge; variations in wearing course surface shall not be more than (b) (7)(E) from the lower edge of the 10 foot straightedge. [Variations in final pervious surface shall not be more than (b) (7)(E) [ ] inch under a (b) (7)(E) straightedge. ] Pavement showing irregularities greater than that specified shall be corrected as directed by Contracting Officer.

#### 3.3.2.3 Alternate Testing Method for Pavement Courses

At Contractor's option the following in-place testing method may be used to determine density and thickness in lieu of testing specified above. Frequency of testing shall be the same. When in-place nuclear method to determine density is used, take two pavement cores at locations designated by Contracting Officer and turn over to Government to verify pavement thickness.

- a. Density: Determine density of pavement by in-place testing using Nuclear Method in accordance with (b) (7)(E).
- b. Thickness: Determine thickness of finished pavement by use of following equation:

(b) (7)(E)



(b) (7)(E)

#### 3.4 WASTE MANAGEMENT

Protect excess material from contamination and return to manufacturer, or reuse on-site for walkways, patching, ditch beds, speed bumps, or curbs.

-- End of Section --

SECTION 32 11 29

LIME-[STABILIZED][MODIFIED] SUBGRADE

11/09

PART 1 GENERAL

1.1 UNIT PRICES

1.1.1 Measurement for Payment

1.1.1.1 Lime [Stabilization] [Modification]

Measurement will be by the square yard of work completed and accepted.

1.1.1.2 Lime

Measurement will be by the number of 2000 pound tons of lime used in the completed and accepted work. No measurement will be made for wasted lime or lime used in work determined defective.

1.1.1.3 Bituminous Material

Bituminous material to be paid for will be measured in the number of [gallons of the material used in the accepted work, corrected to gallons at 60 degrees F in accordance with (b) (7)(E)]. A coefficient of 0.00025 per degree F shall be used for asphalt emulsion.] [2000 pound tons of the material used in the accepted work.]

1.1.2 Basis for Payment

Lime [stabilization] [modification], constructed and accepted, including lime, [bituminous material] and all other materials, labor and equipment required to provide a product meeting the requirements of this specification will be paid for at the respective contract unit prices in the bidding schedule. No payment will be made for any material wasted, used for the convenience of the Contractor, unused or rejected, or for water used. No separate payment will be made for sanding or dusting the bituminous prime-coated surfaces, and all costs for sanding or dusting shall be included in the contract unit price for bituminous material.

1.1.3 Waybills and Delivery Tickets

Submit copies of waybills or delivery tickets during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all lime [and bituminous materials] used in the construction.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

(b) (7)(E)

### 1.3 DEFINITIONS

#### 1.3.1 Lime-[Stabilized][Modified] Course

Lime-[stabilized][modified] course, as used in this specification, is a mixture of lime and in-place or borrow material uniformly blended, wetted, and thoroughly compacted to produce a pavement course which meets the criteria set forth in the plans and this specification.

#### 1.3.2 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in (b) (7)(E) abbreviated as percent laboratory maximum density.

### 1.4 SYSTEM DESCRIPTION

The work specified consists of the construction of a lime-[stabilized][modified] subgrade course. Perform the work in accordance with this specification conforming to the lines, grades, notes, and typical sections shown in the drawings. Select sources of materials well in advance of the time when materials will be required in the work.

#### 1.4.1 Stockpiling Materials

Stockpile borrow material, including approved material available from excavation and grading, in the manner and at the locations designated. Before stockpiling material, storage sites shall be cleared and sloped to drain. Stockpile separately materials obtained from different sources.

#### 1.4.2 Plant, Equipment, Machines, and Tools

##### 1.4.2.1 General Requisites

Plant, equipment, machines, and tools used in the work shall be subject to approval and maintained in satisfactory working condition at all times. Other compacting equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. Provide protective equipment, apparel, and barriers to protect the eyes, respiratory system, and the skin of workers exposed to contact with lime dust or slurry.

##### 1.4.2.2 Steel-Wheeled Rollers

Steel wheeled rollers shall be the self propelled type. Unless otherwise provided, non-vibratory steel-wheel rollers shall be of the tandem or 3-wheel self-propelled type or steel-wheel trailer type weighing not less than 5 tons. When drive rolls or trailer type rolls produce a compressive force of not less than 200 pounds per linear inch of contact area, a roller weighing less than 5 tons may be used. Equip wheels of the rollers with adjustable scrapers. The use of vibratory rollers is optional.

##### 1.4.2.3 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall have 4 or more tires, inflated to a minimum pressure of 90 psi. The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Also provide pneumatic-tired towing equipment.

##### 1.4.2.4 Tamping-Type Roller

The tamping type roller, under working conditions, shall have a minimum weight of 90 pounds per linear inch of length of drum and a minimum load on each sheeps-foot of 100 pounds per square inch of cross sectional area of the sheeps-foot in contact with the ground. Maximum area of the face of each sheeps-foot shall not be more than 12 square inches. The feet on the sheeps-foot roller shall project not less than 7 inches from the face of the drum, and the roller shall be equipped with teeth-cleaning devices. Space the feet in adjacent rows so that the distance from center to center of adjacent parallel rows is not less than 6 inches nor more than 11 inches. Individual drums of the roller shall not exceed 5 feet in width and shall oscillate independently. Roller and tractor for pulling shall travel at a speed of approximately 3 to 6 mph.

##### 1.4.2.5 Mechanical Spreader

Mechanical spreader shall be self-propelled or attached to a propelling unit capable of moving the spreader and material truck. The device shall be steerable and shall have variable speeds forward and reverse. The spreader and propelling unit shall be carried on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. Provide a spreader containing a hopper, an adjustable screed, and outboard bumper rolls; designed to have a uniform, steady flow of material from the hopper; and capable of laying material without segregation, across the full width of the lane, to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers conform to thickness and grade requirements indicated. The Contracting Officer may require a demonstration of the spreader prior to approving use in performance of the work.

##### 1.4.2.6 Pulvimixer

The pulverizing and mixing equipment shall be self-propelled, four-wheel drive, and capable of pulverizing the soil in a single pass for the full depth to be stabilized. The mixing action shall be capable

of uniformly blending and mixing the required lime content with the subgrade soil. The rotor shall be capable of up or down cutting.

#### 1.4.2.7 Slurry Mixer/Distributor

Mix the lime with water in trucks with approved distributors and applied as a thin water suspension or slurry. Apply commercial lime slurry with a lime percentage not less than that applicable for the grade used. Attain the distribution of lime by successive passes over a measured section of subgrade until the proper amount of lime has been spread. The amount of lime spread shall be the amount required for mixing to the specified depth that will result in the percentage determined in the job mix formula. The distributor truck shall continually agitate the slurry to keep the mixture uniform.

#### 1.4.2.8 Central Mixing Plant

A lime-slurry central mixing plant shall consist of a lime storage silo, water supply tank, lime and water metering devices, and a lime-water mixer.

Provide storage tanks for lime-water slurry with mechanical agitation to maintain the lime-water slurry in suspension.

#### 1.4.2.9 Sprinkling Equipment

Provide sprinkling equipment consisting of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

#### 1.4.2.10 Tampers

Provide tampers of an approved mechanical type, having sufficient weight and striking power to produce the compaction required.

#### 1.4.2.11 Straightedge

Furnish and maintain at the site, in good condition, one 12 foot straightedge for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal with blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

### 1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-03 Product Data

Plant, Equipment, Machines, and Tools[; G][; G, [\_\_\_\_]]

List of proposed equipment to be used in performance of construction work including descriptive data.

Mix Design[; G][; G, [\_\_\_\_]]

Mix design for each material type to be [stabilized] [modified] at least [14] [\_\_\_\_\_] days before it is to be used.

#### Waybills and Delivery Tickets

Copies of waybills and delivery tickets during the progress of the work. Certified waybills and delivery tickets for all materials actually used.

#### SD-o6 Test Reports

##### Sampling and Testing Field Density

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within [24] [\_\_\_\_\_] hours after the tests are performed. Certified copies of test results of materials and sources not less than [30] [\_\_\_\_\_] days before material is required for the work.

#### SD-o7 Certificates

##### Bituminous Material.

Copies of certified test data.

##### Lime

Copies of certified test data.

##### Laboratory

Certification of testing laboratory compliance.

### 1.6 ENVIRONMENTAL REQUIREMENTS

Do not work during freezing temperatures. When the temperature is below 40 degrees F, protect the completed [stabilized] [modified] materials against freezing by a sufficient covering of straw, or by other approved methods, until the course has dried out. Any areas of completed [stabilized] [modified] materials that are damaged by freezing, rainfall, or other weather conditions shall be brought to a satisfactory condition without additional cost to the Government. Do not apply lime when the atmospheric temperature is less than 40 degrees F or to soils that are frozen or contain frost, or when the underlying material is frozen. If the temperature falls below 35 degrees F completed lime-treated areas shall be protected against any detrimental effects of freezing.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Lime

Lime shall be a standard brand of [quicklime] [hydrated lime] conforming to (b) (7)(E) and the following physical and chemical requirements. Sample lime in accordance with (b) (7)(E).

- a. Lime shall be of such gradation that (b) (7)(E)
- b. (b) (7)(E).
- c. [Quicklime] [Hydrated Lime] shall (b) (7)(E) (taken at the point of manufacture).

#### 2.1.2 Bituminous Material

Material shall conform to one of the following:

##### 2.1.2.1 Cutback Asphalt

(b) (7)(E) [\_\_\_\_].

##### 2.1.2.2 Emulsified Asphalt

(b) (7)(E) [\_\_\_\_].

##### 2.1.3 Material to be [Stabilized] [Modified]

Material to be [stabilized] [modified] shall consist of in situ, borrow, or compacted fill material. Provide material free of deleterious substances such as sticks, debris, organic matter, and stones greater than 3 inches in any dimension. (b) (7)(E) [Plasticity index shall be (b) (7)(E)].

##### 2.1.4 Water

Water shall be clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other substances deleterious to the lime or soil-lime mixture, and shall be subject to approval. Water shall be tested and conform to the requirements of (b) (7)(E) including the optional requirements of Table 2. Potable water sources may be used without testing.

#### 2.2 MIX DESIGN

[Develop and submit for approval a proposed mix design for each material type to be [stabilized] [modified]. Obtain approval of the proposed mix designs prior to starting the work. Mix designs shall be developed by an approved commercial laboratory which meets the requirements of (b) (7)(E) [and which has been approved by the Corps of Engineers Materials Testing Center]. Develop the mix design using representative samples of each soil to be [stabilized] [modified] and using the proposed project lime. Conduct three trials for each mix design tested. Prepare samples in accordance with (b) (7)(E). Allow the prepared samples to mellow for [24 hours for modified materials] [48 hours for stabilized materials] before any testing is performed.[ For soil stabilization, vary the lime content to produce a maximum plasticity index (b) (7)(E) when tested in accordance with (b) (7)(E). Provide the results in a graph of plasticity index versus lime content. Determine the maximum dry density and optimum moisture content for the proposed lime-soil mixture in accordance with (b) (7)(E). Cure samples at a constant moisture content and temperature for [7] [28] [\_\_\_\_] days.[ The soil stabilization mix design shall be capable of producing a unconfined compressive strength of [\_\_\_\_] (b) (7)(E) at 28-days [\_\_\_\_] age (average of three specimens) when compacted to the design percent of laboratory maximum density and tested in accordance with (b) (7)(E) Prepare three specimens per test evaluation for durability testing for each mix design tested. Samples shall not exceed loss indicated in Table 2 after 12 cycles of the



wet-dry test in accordance with [REDACTED] (b) (7)(E) [REDACTED].] [ Conduct freeze thaw tests in accordance with [REDACTED] (b) (7)(E) [REDACTED] ] (but omitting wire brushing) for projects susceptible to freeze/thaw conditions.] The mix design submittal information shall include the following:

- a. Material type
- b. Material classification including plasticity test data
- c. Laboratory maximum density
- d. Percent of lime and rate of application
- e. Optimum water content during mixing, curing, and compaction
- f. Gradation of material before and after treatment
- g. Compressive strength
- h. Durability Wet-Dry [and Freeze/Thaw] test data
- i. Mixing or equipment requirements
- j. Mellowing time requirements
- k. Water quality test data, if non-potable source used

Table 2	
Type of Soil Stabilized	Maximum Allowable Weight Loss After 12 Wet-Dry or Freeze-Thaw Cycles Percent of Initial Specimen Weight
Silt	8
Clays	6

] [The in situ soil or compacted fill shall be modified with lime at a rate of [REDACTED] percent to [REDACTED] percent per dry unit weight of soil.]

### PART 3 EXECUTION

#### 3.1 LIME [STABILIZATION] [MODIFICATION] MIXTURE

The subgrade material to be [stabilized] [modified] shall be thoroughly pulverized and, [ when lime is applied in the dry state,] the mix shall be thoroughly blended at a moisture content below optimum. After blending is completed, the proportions of the mixture shall be in accordance with the approved mix design. After blending, water shall be added into the dry mix in amounts necessary to bring the moisture content to a minimum of [3] [REDACTED] percent above optimum. Control field moisture content within plus [2] [REDACTED] or minus [1] [REDACTED] percent of optimum. When the [stabilized] [modified] course is constructed in more than one layer, clean the previously constructed layer of loose and foreign matter by sweeping with power sweeper or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Provide adequate drainage during the entire construction period to prevent water from collecting or standing on the area to be [stabilized] [modified] or on pulverized, mixed, or partially mixed material. Provide line and grade stakes as necessary for control. Place grade stakes in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

#### 3.2 OPERATION OF BORROW PITS

[Borrow pits shall be cleared, stripped and excavated in a manner that exposes vertical faces of the deposit for suitable working depths. Strata of unsuitable materials overlying or occurring in the deposit shall be wasted. Methods of operating pits and the processing and blending of materials may be changed or modified if necessary to obtain material conforming to the specified requirements. Upon completion of the work, pits shall be conditioned to drain readily, and be left in a satisfactory condition as determined by the Government.] [Obtain borrow material from offsite sources.]

### 3.3 PREPARATION OF AREA TO BE [STABILIZED] [MODIFIED]

Clean the area of debris, roots, thrash, organic and other deleterious materials. The area will be inspected for adequate compaction and shall be capable of withstanding, without displacement, the compaction specified for the soil-lime mixture. Debris and removed unsatisfactory in-place material shall be disposed of as specified.

#### 3.3.1 In-Place Material to be [Stabilized] [Modified]

Grade the entire area to conform to the lines, grades, and cross sections shown in the drawings prior to being processed. Soft or yielding subgrade areas shall be made stable before construction is begun. Unsatisfactory material shall be removed and replaced as directed by the Government.

#### 3.3.2 In-Place Material to Receive [Stabilized] [Modified] Course

[Correct soft, yielding areas and ruts or other irregularities in the surface. The material in the affected areas shall be loosened and unsatisfactory material removed. Add approved material where directed. The area shall then be shaped to line, grade, and cross section, and shall be compacted to the specified density.] [Subgrade shall conform to Section 31 00 00 EARTHWORK.]

#### 3.3.3 Grade Control

Excavate underlying material to sufficient depth for the required [stabilized][modified]-course thickness so that the finished [stabilized] [modified] course with the subsequent surface course will meet the fixed grade. Finished and completed stabilized area shall conform to the lines, grades, cross section, and dimensions indicated.

### 3.4 INSTALLATION

#### 3.4.1 Mixed In-Place Method

##### 3.4.1.1 Scarifying and Pulverizing of Soil

Prior to application of lime, the soil shall be scarified and pulverized [to the depth shown] [to a depth of [\_\_\_\_\_]inches]. Scarification shall be controlled so that the layer beneath the layer to be treated is not disturbed. Depth of pulverizing shall not exceed the depth of scarification.

##### 3.4.1.2 Application of Lime

Shape pulverized material to approximately the cross section indicated. Apply lime so that when uniformly mixed with the soil, the specified lime content is obtained, and a sufficient quantity of lime-treated soil is produced to construct a compacted lime-treated course conforming to the lines, grades, and cross section indicated. Lime shall be spread only on areas where the mixing operations can be completed during the same work shift or day.[ Use mechanical spreaders in applying bulk lime.] [ Apply lime as a slurry, and use distributors in applying slurry.] If lime is spread by hand, the bags shall be spotted accurately on the area being stabilized so that when the bags are opened the lime will be

dumped and spread uniformly on the area being processed. Limit hand spreading to areas inaccessible to mechanical spreaders. No equipment, except that used in spreading and mixing, shall pass over the freshly applied lime.

#### 3.4.1.3 Initial Mixing

Mix the lime and soil immediately after the lime has been distributed. Initial mixing shall be sufficient to alleviate any dusting or wetting of the lime that might occur in the event of wind or rainstorms. This may be accomplished several days in advance of the final application and mixing.

#### 3.4.1.4 Water Application and Moist Mixing

Determine moisture content of the mixture in preparation for final mixing. Moisture in the mixture following final mixing shall not be less than the water content determined to be optimum based on dry weight of soil and shall not exceed the optimum water content by more than [2] [\_\_\_\_] percentage points. Water may be added in increments as large as the equipment will permit; however, such increment of water shall be partially incorporated in the mix to avoid concentration of water near the surface. After the last increment of water has been added, continue mixing until the water is uniformly distributed throughout the full depth of the mixture, including satisfactory moisture distribution along the edges of the section. Soil shall be mixed in two stages, allowing for an intervening 24 to 48 hour mellowing period. The [stabilized] [modified] mixture should mellow sufficiently to allow the chemical reaction to alter (break down) the material. The duration of this mellowing period shall be identified in the mix design and should be based on soil type. After mellowing, the soil shall be remixed before compaction.

#### 3.4.1.5 Confined Areas

In areas inaccessible to machinery, excavate soils to be [stabilized] [modified] and move to an area where machine mixing may be performed, processed, and placed back in the original location. Place material in its final location within 24 hours of initial mixing, and prior to final mixing and compaction.

#### 3.4.2 Edges of [Stabilized] [Modified] Course

Place approved material along the edges of the [stabilized] [modified] course in a quantity that will compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple-layer course, allowing at least a 1 foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the [stabilized] [modified] course.

#### 3.4.3 Central-Plant Method

Provide a plant capable of producing a uniform lime-treated mixture at the specified lime and moisture contents. Haul the mixture to the job in trucks equipped with protective covers. Underlying course shall be thoroughly moistened and the mixture then placed on the prepared area in a uniform layer with mechanical spreaders. The layer shall be uniform in thickness and surface contour; and the completed layer, after compaction, shall conform to the required grade and cross section.

#### 3.4.4 Traveling-Plant Method

Traveling plant shall move at a uniform rate of speed and shall accomplish thorough mixing of the materials in one pass. Deliver water and lime from supply trucks or bins at a predetermined rate. Windrows of prepared soil-lime mixture shall cover a predetermined width to the indicated compacted thickness.

#### 3.4.5 Layer Thickness

Compacted thickness of the [stabilized] [modified] course shall be [as indicated] [[\_\_\_\_\_]inches]. No layer shall be more than (b) (7)(E) n compacted thickness.

#### 3.4.6 Compaction

Before compaction operations are started and as a continuation of the mixing operation, the mixture shall be thoroughly loosened and pulverized to the full depth. Start compaction immediately after final mixing is completed. During final compaction moisten the surface, if necessary, and shape it to the required lines, grades, and cross section. Density of compacted mixture shall be at least [90] [\_\_\_\_\_] percent of laboratory maximum density. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Make alternate trips of the roller slightly different lengths. At all times, the speed of the roller shall not cause displacement of the mixture to occur. Compact areas inaccessible to the rollers with mechanical tampers; shape and finish the areas by hand methods.

#### 3.4.7 Finishing

Finish the surface of the top layer to the grade and cross section shown. The surface shall be of uniform texture. Light blading during rolling may be necessary for the finished surface to conform to the lines, grades, and cross sections. If for any reason the surface becomes rough, corrugated, uneven in texture, or traffic-marked prior to completion, the unsatisfactory portions shall be scarified, reworked, relaid, or replaced as directed. If any portion of the course, when laid, becomes watersoaked for any reason, that portion shall be removed immediately, and the mix placed in a windrow and aerated until a moisture content within the limits specified is obtained; and then spread, shaped, and rolled as specified above.

#### 3.4.8 Construction Joints

At the end of each phase of construction, form a straight transverse construction joint by cutting back into the completed work to form a true vertical face free of loose or shattered material. Material along construction joints not properly compacted shall be removed and replaced with soil-lime mixture that is mixed, moistened, and compacted as specified.

#### 3.4.9 Curing and Protection

Immediately after the soil-lime area has been finished as specified above, the surface shall be protected against rapid drying for 7 days by the application of a bituminous material.

Uniformly apply bituminous material by means of a bituminous distributor within a temperature range of [\_\_\_\_\_] to [\_\_\_\_\_] degrees F. Bituminous material shall be applied in quantities of (b) (7)(E) . Areas inaccessible to or missed by the distributor shall be properly treated using the manually operated hose attachment. Apply bituminous material only to the top layer. At the time the bituminous material is applied, the surface of the area shall be free of loose or foreign matter and shall contain sufficient moisture to prevent excessive penetration of the bituminous material. When necessary, sprinkle the area immediately before the bituminous material is applied. Treated surface shall be [sanded] [dusted] [\_\_\_\_\_] to prevent the bituminous material from being picked up by traffic.

### 3.5 SAMPLING AND TESTING

#### 3.5.1 General Requirements

Perform sampling and testing using an approved commercial testing laboratory or facilities furnished by the Contractor. Work requiring testing will not be permitted until the facilities have been inspected and approved. The first inspection will be at the expense of the Contractor. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Perform tests in sufficient numbers and at the locations and times directed to ensure that materials and compaction meet specified requirements. Furnish certified copies of the test results to the Contracting Officer within 24 hours of completion.

### 3.5.2 Results

Results shall verify that the material complies with the specification. When [the source of materials is changed] [deficiencies are found], repeat the initial analysis including mix design studies if the material source is changed, and retest the material already placed to determine the extent of unacceptable material. Replace all in-place unacceptable material.

### 3.5.3 Sampling

Take all aggregate samples for laboratory testing in accordance with (b) (7)(E). Take samples of lime in accordance with (b) (7)(E). Prepare specimens for the unconfined compression tests in accordance with (b) (7)(E).

### 3.5.4 Sieve Analysis

Before starting work, test one sample of material to be [stabilized] [modified] in accordance with (b) (7)(E) on sieves conforming to (b) (7)(E). After the initial test, perform a minimum of one analysis for each [1000] [ ] tons of material placed, with a minimum of three analyses for each day's run until the course is completed.

### 3.5.5 Liquid Limit and Plasticity Index

Perform one liquid limit and plasticity index for each sieve analysis. Liquid limit and plasticity index shall be in accordance with (b) (7)(E).

### 3.5.6 Chemical Analysis

Test lime for the specified chemical requirements in accordance with (b) (7)(E).

## 3.6 FIELD QUALITY CONTROL

Provide a moisture-density relationship for the lime-soil mixture from the tests. Results of field quality control testing shall verify that materials comply with this specification. When a material source is changed, [test the new material for compliance] [ ]. When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or repaired, as directed by the Contracting Officer, at no additional cost to the Government.

### 3.6.1 Treatment Depth Checks

The depth of stabilization shall be measured at a frequency intervals for each of [[250] [ ] square meters ([250] [ ] square yards)] [[250] [ ] square yards] of [stabilized] [modified] course. Measurements shall be made in test holes soil by spraying with a pH indicator such as phenolphthalein. Phenolphthalein changes from clear to red between pH 8.3 and 10. The color change indicates the

location of the bottom of the mixing zone. Other pH indicators can measure higher pH levels if there is reason to suspect that inadequate lime has been mixed into the soil.

### 3.6.2 Thickness Control

Completed thicknesses of the [stabilized] [modified] course shall be within  $\frac{1}{2}$  [ $\frac{1}{4}$ ] inch of the thickness indicated. Where the measured thickness of the [stabilized] [modified] course is more than  $\frac{1}{2}$  [ $\frac{1}{4}$ ] inch deficient, correct such areas by scarifying, adding mixture of proper gradation, reblading, and recompacting as directed. Where the measured thickness of the [stabilized] [modified] course is more than  $\frac{1}{2}$  [ $\frac{1}{4}$ ] inch thicker than indicated, it shall be considered as conforming to the specified thickness requirement. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within  $\frac{1}{4}$  inch of the thickness indicated. Thickness of the [stabilized] [modified] course shall be measured at intervals which ensure one measurement for each [250] [\_\_\_\_\_] square yards of [stabilized] [modified] course. Measurements shall be made in 3 inch diameter test holes penetrating the [stabilized] [modified] course.

### 3.6.3 Field Density

Determine field in-place density in accordance with (b) (7)(E) [redacted] is used, the calibration curves shall be checked, and adjusted if necessary, using the sand cone method as described in paragraph Calibration of the ASTM publication.] (b) (7)(E) [redacted] may be used to determine both the wet unit weight and the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in (b) (7)(E) [redacted] is used, in-place densities shall be checked by (b) (7)(E) [redacted] at least once per lift and at a frequency not to exceed one test under (b) (7)(E) [redacted] [\_\_\_\_\_] tests performed under (b) (7)(E) [redacted]. Furnish calibration curves and calibration tests results to the Contracting Officer within 24 hours of conclusion of the tests. Perform at least one field density test for each [250] [\_\_\_\_\_] square yards of each layer of [stabilized] [modified] material.

### 3.6.4 Smoothness Test

The surface of a [stabilized] [modified] layer shall show no deviations in excess of  $\frac{1}{2}$  inch when tested with the [10-] [12-] foot straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed. Take measurements for deviation from grade and cross section shown in successive positions parallel to the pavement centerline with a [10-] [12-] foot straightedge. Measurements shall also be taken perpendicular to the pavement centerline at [50-] [\_\_\_\_\_] foot intervals.

### 3.7 TRAFFIC

Completed portions of the lime-treated soil area may be opened to light traffic after a period of 3 days if cured with a bituminous material provided the curing is not damaged. After the curing period has elapsed, completed areas may be opened to all traffic, provided the [stabilized] [modified] course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. Heavy equipment is not permitted on the area during the curing period. [Lime and water may be hauled over the completed area with pneumatic-tired equipment if approved.] Protect finished portions of lime-[stabilized] [modified] soil, that are traveled on by equipment used in constructing an adjoining section, in a manner to prevent equipment from marring or damaging completed work.

### 3.8 MAINTENANCE

Maintain [stabilized] [modified] area in a satisfactory condition until the completed work is accepted. Maintenance shall include immediate repairs of any defects and shall be repeated as often as necessary to keep the area intact. Correct defects as specified herein.

### 3.9 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for stabilization, material that is removed for the required correction of defective areas, waste material, and debris shall be disposed of [as directed] [in waste disposal areas indicated].

-- End of Section --

SECTION 32 11 30

LIME TREATED SUBGRADE [LIME MODIFIED SOILS]  
08/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)



(b) (7)(E)

NATIONAL LIME ASSOCIATION (NLA)

(b) (7)(E)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-04 Samples

Cured lime-treated material

Lime

Submit a typical cured sample of on-site material with the required percent of lime content.

### SD-05 Design Data

Job-mix formula

Mixing procedures

Analysis of equipment

### SD-06 Test Reports

Site preparation test

Final compaction report

[Field application rate test]

### SD-07 Certificates

Bituminous curing seal

Lime

Contractor equipment list

Submit a list of construction equipment 7 days prior to bringing equipment on the job.

## 1.3 DELIVERY AND STORAGE

Deliver lime, bituminous materials in containers showing or including designated trade name, product identification, specification number, manufacturers name, and source. Store in a manner that will prevent moisture damage, overexposure, and contamination.

#### 1.4 WEATHER LIMITATIONS

Do not construct subgrade when weather conditions detrimentally affect the quality of the materials. Do not apply lime unless the air temperature is at least 40 degrees F in the shade and rising. Do not apply lime to soils that are frozen or contain frost. If the air temperature falls below 35 degrees F in the shade, protect completed lime-treated areas by approved methods against the detrimental effects of freezing. Remove and replace any damaged portion of the completed soil-lime treated area with new soil-lime material in accordance with this specification.

##### 1.4.1 Freeze Protection Method(s)

- a. Submit Contractor's plan(s) for freeze protection to Contracting Officer for approval.

#### 1.5 QUALITY ASSURANCE

##### 1.5.1 Required Data

[Ten] [\_\_\_\_\_] days prior to the commencement of the work, a job-mix formula showing the amount of lime and water required per cubic yard, and procedures for blending the lime/subgrade mixture for each type of existing soil. Include process type and number of: Lime applications, stages of mixing, slurry injection depths, mixing depths and depths of compaction lifts. Also, a list of equipment to be used and their relation to method of mixing proportioning, spreading, pulverizing and compacting subgrade, slurry injection, jet slurry mixing and other related work. The formula shall also contain amount of lime, either in sacks or pounds per cubic yard and the amount of water to be used, if slurry method is used. Use the following laboratory test method when applicable: (b) (7)(E).

## PART 2 PRODUCTS

### 2.1 LIME TREATMENT REQUIREMENTS

Perform lime treatment of subgrade. Scarify subgrade soil and mix uniformly with lime and water, spread, shape, compact and cure in accordance with these specifications and the following requirements:

- a. Lime requirement: The percent of [hydrated lime] [quicklime] by weight of dry soil material: [\_\_\_\_\_] percent.

#### 2.1.1 Hydrated Lime

##### 2.1.1.1 Type I

(b) (7)(E)

##### 2.1.1.2 Type II

(b) (7)(E)

##### 2.1.1.3 Type III

(b) (7)(E)  
and in compliance with (b) (7)(E).

2.1.1.4 Type IV

By-Product, Waste, Salvaged or Specially Formulated Lime. (b) (7)(E) with the following modifications:

- a. Total (b) (7)(E) equal (b) (7)(E) [\_\_\_\_\_] minimum.
- b. Available (b) (7)(E) (b) (7)(E) equal (b) (7)(E) minimum.
- c. (b) (7)(E) (b) (7)(E) maximum sampled at place of manufacture or (b) (7)(E), if sampled other than at place of manufacture.
- d. Free water (as received basis) equal (b) (7)(E) maximum.
- e. Residue: Sieve analysis of lime as follows:

<u>Sieve</u>	<u>Maximum Percent Retained</u>
--------------	---------------------------------

(b) (7)(E)	(b) (7)(E)
------------	------------

- f. No requirements for plasticity, pops or pits, or water retention.

2.1.1.2 Quicklime

2.1.2.1 Type V

High calcium quicklime containing at least 113 percent calcium hydroxide determined by (b) (7)(E) and (b) (7)(E) testing procedures.

<u>Sieve</u>	<u>Maximum Percent Retained</u>
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(b) (7)(E)	(b) (7)(E)
------------	------------

2.1.2.2 Type VI

(b) (7)(E)

2.2 SOIL

The inorganic natural material in the area to be stabilized[ unless imported material, relocated material, or preliminary earthwork is required: See Section 31 00 00 EARTHWORK]. Remove stones retained on a 3 inch sieve and deleterious substances such as sticks, debris, and vegetable matter.

2.3 WATER

Potable

## 2.4 BITUMINOUS CURING SEAL

### 2.4.1 Emulsified Asphalt

Conform to (b) (7)(E) [\_\_\_\_]. The base asphalt used to manufacture the emulsion shall show a (b) (7)(E) when tested in accordance with (b) (7)(E)

## PART 3 EXECUTION

### 3.1 SITE PREPARATION

Clean debris from area to be stabilized. Perform clearing and grubbing [to a depth of [\_\_\_\_] inches] [as specified in Section [31 11 00 CLEARING AND GRUBBING] [31 00 00 EARTHWORK]] [as required]. Remove rocks larger than 3 inches. Inspect original ground for adequacy for the forthcoming compactive effort of lime treatment work. [Rough grade and shape the area to be stabilized to conform to the lines, grades, and cross sections indicated.] [Comply with subgrade requirements of Section 31 00 00 EARTHWORK].

#### 3.1.1 Grade Control

When stabilized course is to be constructed to meet a fixed grade, provide adequate line and grade stakes for control. Finished and completed stabilized areas shall conform to the lines, grades, cross section, and dimensions indicated. Locate grade stakes in lanes parallel to center line of areas under construction, and suitably placed for string lining. Maintain line and grade.

#### 3.1.2 Soil Testing

Test original ground prior to scarification in accordance with (b) (7)(E).

### 3.2 LIME TREATMENT AND SEQUENCE OF CONSTRUCTION OPERATIONS

Comply with (b) (7)(E) and sequence of construction operations, unless specified otherwise hereinafter.

#### 3.2.1 Application Requirements

After site preparation, scarify subgrade and spread lime. Blend lime into subgrade to required depth as indicated. Apply lime and water only to those areas where mixing operations can be completed during the same working day. Accomplish application and mixing of lime by either the dry placing method or the slurry method. Use same method during any single days operation. [Double application of lime is required; percentage of lime for the initial application shall be between 2 and 3 percent. Apply curing seal as specified hereinafter and allow 6 to 7 days curing.]

#### 3.2.2 Scarification

After obtaining required line and grade, scarify and partially pulverize the subgrade. Remove organic materials such as stumps and roots. Remove rocks larger than 3 inches.

#### 3.2.3 Dry Placing

Spread and distribute lime at a uniform rate with protection from wind as an important distribution and timing criteria. Prevent dry lime from blowing by adding water to lime or by other suitable means. Do not apply lime when wind conditions, in the opinion of the Contracting Officer, are objectionable.

#### 3.2.4 Slurry Method

Apply or inject mixture of lime and water into the existing soil. Maintain the water content at 5 percent above optimum during application to lime/soil mixture. Prepare hydrate slurry either in a central mixing tank or tank trucks, with agitation provided for mixing or using a jet slurry maker. Prepare quicklime slurry using a portable batch slaking unit. Accurately weigh or meter lime and water. Standard water or asphalt trucks, properly cleaned, with or without pressure distributors, may be used to apply lime treatment. Spread or inject lime slurry evenly to yield uniform distribution of lime throughout soil. Distribute lime in successive passes over subgrade materials until proper amount of lime has been spread or injected to proper depth. Continually agitate slurry to keep mixture uniform. Keep pumps, distribution spray bars, slurry injection equipment and other equipment clean of excessive lime slurry. The Contractor's laboratory shall verify the specified amount and rate of application of lime for the various materials encountered.

#### 3.2.5 Preliminary Mixing and Watering

Distribute lime uniformly by mixing and pulverizing subgrade. During mixing, add water to subgrade to provide a moisture content of 5 percent above optimum moisture content of material and to insure chemical action of lime and subgrade materials. Mixer shall continue making passes until it has produced a homogeneous, uniform mixture of lime, soil, and water. Continue mixing or remixing operations, until material is free of streaks or pockets of lime and mixture is uniform as indicated by testing. After initial mixing, shape and roll subgrade lightly to seal surface in order to reduce evaporation of moisture and lime carbonation.

#### 3.2.6 Preliminary Curing

Moisture cure lime-soil mixture up to 48 hours until adhesive quality of clay is reduced to almost normal soil consistency. Allow 7 days or more for curing heavy clays.

#### 3.2.7 Mixing, Uniformity Testing and Compaction

After dry lime or lime slurry is uniformly applied to soil and mixture is pulverized and cured, continue mixing until individual agglomerates of soil do not exceed one inch in maximum dimension (soil particles will pass (b) (7)(E)). Continue mixing and re-mixing until material is uniformly mixed. Moisture shall be (b) (7)(E). Compact lime-treated material immediately after final mixing and testing. Aerate or sprinkle as necessary to provide optimum moisture content during compaction. Compact lime-treated material in specified lifts (b) (7)(E). Base density value on a representative soil sample obtained from site and treated with required proportion of lime. As compaction progresses, maintain the shape of the lifts by blading. Surface upon completion shall be smooth and conform to indicated section and established lines and grades. Perform initial compaction with sheepfoot roller or other suitable roller. Perform final rolling by means of sheepfoot, steel-tired, or pneumatic rollers.

#### 3.2.8 Two-Stage Pulverization and Mixing

After curing, pulverize lime treated material until soil particles pass a (b) (7)(E). If resultant mixture contains clods, reduce their size by scarifying, remixing, or pulverization to meet specified gradation.

### 3.2.9 Finishing

Surface of finished lime-treated material after compaction shall be the established graded plane. At any point the surface shall not vary more than 0.05 foot [ ] above or below established grade. Finish completed section by rolling with a pneumatic or suitable roller sufficiently light to prevent hairline cracking. Keep surface of each compacted layer of lime-treated material moist until covered by a subsequent layer of lime-treated material or curing seal.

### 3.2.10 Limit of Daily Operations (Temporary Joints)

At the end of each working day, prepare a temporary joint in fully compacted material normal to paved surface centerline. Construct a longitudinal temporary joint for partial width sections against which future material is to be placed. Remove temporary joints during next work period by trimming 3 inches into treated material for continuity. Trimmed material may be incorporated in subsequent work. Temporary joints shall not coincide with any longitudinal or transverse temporary joint location of previous or subsequent construction. Remixing 4 inches into the previous day's work may be substituted for joints providing the method and equipment is acceptable to the Contracting Officer.

### 3.2.11 Final Curing

#### 3.2.11.1 Curing

Cure lime-treated material for 72 hours. During curing period, add [water] [bituminous curing seal] to surface to maintain moisture content of mixture at five percent above optimum water content. Lime that has been overexposed to open air shall be removed and disposed of off-station.

- a. Moist curing (water only): Keep surface damp by sprinkling and use light rollers to keep surface knitted together (preventing surface cracks) until following course of material is placed.
- b. Asphalt emulsion curing seal: Apply at least two applications uniformly to top (final) layer of lime-treated material at a rate of 0.15 to 0.20 gallons per square yard of surface. Apply curing seal same day as soon as possible after completion of final rolling, before temperature falls below 40 degrees F.

### 3.3 TRAFFIC CONTROL, CURING MAINTENANCE AND DRAINAGE PROTECTION

Keep traffic off surfaces freshly treated with bituminous material. Provide warning signs and barricades so that traffic will not travel over freshly treated surfaces. Do not permit equipment or traffic on lime-treated material until subgrade stability is assured. Maintain finished surface until work has been completed. Provide drainage during entire period of construction to prevent water from collecting or standing on area to be stabilized.

### 3.4 EQUIPMENT LIMITATIONS

#### 3.4.1 General

The type of equipment to be used for each category of work shall conform to the (b) (7)(E) unless specified otherwise. Maintain equipment in satisfactory and safe operating condition.

#### 3.4.2 Spreading Equipment

At windy locations use an approved screw type spreader box, mixer, or other semi-enclosed equipment which will offer protection from wind. Spreading hydrated lime by aggregate spreaders, dump trucks or agricultural spreaders is not allowed. Spreading by end-dumping, or tailgate control methods are not allowed. Change or alter equipment to be used in the event of non-uniform spreading of lime.

#### 3.4.3 Additional Mixing Equipment Limitations

- a. Motor graders will not be allowed to mix lime with clays.
- b. Deep-lift rotary mixers may be used and may facilitate changes in specified depths of operation, providing equipment and method of operation sustains uniform distribution of lime with required compacted density throughout the deeper layer, with approval of Contracting Officer.

#### 3.4.4 Additional Compaction Equipment Limitations

Unauthorized equipment, hauling or transportation vehicles will not be allowed for compaction purposes.

### 3.5 SAFETY REQUIREMENTS

In addition to the Contract Clause entitled "Accident Prevention", prevent employee eye or skin contact with quicklime during transport or application. Provide and require employees use the following:

- a. Protective clothing, high top boots, gauntlet-type gloves and protective headwear
- b. Splash-proof safety goggles and face shields
- c. Protective cream.

### 3.6 TESTS

#### 3.6.1 General

Perform sampling and testing using a laboratory which has been inspected by the Cement and Concrete Reference Laboratory (of ASTM/CCRL) within the past 3 years or by a Government approved independent commercial testing laboratory. Frequency of sampling and testing of materials for conformance and quality control shall be as specified herein and shall be performed at such other times as necessary to document contract compliance. Test reports and results shall be certified by the laboratory and submitted together with Contractor's daily certification.

#### 3.6.2 Optimum Moisture, Maximum Density

Perform optimum moisture, maximum density test on lime-treated material sampled after final mixing and prior to final compaction. Soil mixture shall be laboratory compacted within 3 hours of sampling and then moist-cured for 24 hours prior to optimum moisture-maximum density determination. Test in accordance with (b) (7)(E) and the Job-Mix Formula.

#### 3.6.3 Uniformity Tests

After placement and mixing of each lift perform a series of uniformity tests. Excavate a hole 10 inches in diameter through full depth of lift and impregnate sides of hole with a standard phenolphthalein alcohol

indicator. Non-conformity of color reaction, when material is treated as above, will be considered evidence of inadequate mixing.

#### 3.6.4 Compaction

Perform in-place density test to determine degree of compaction between 24 and 72 hours after final compaction and 24 hour moist cure period. Test in accordance with (b) (7)(E). [Subject to approval of the Contracting Officer the following test methods may be included: (b) (7)(E) and compatible meter methods providing one (b) (7)(E) check test is made after every [four] [ ] nuclear tests.]

#### 3.6.5 Thickness and Smoothness

Thickness of final lime treated subgrade shall be not less than thickness shown. Final grade smoothness shall not deviate by more than 3/8 inch, when tested with a 10 foot straightedge.

#### [3.6.6 Field Application Rate Test

Test for checking initial lime spreading rate.

#### ]3.6.7 Frequency of Tests

The minimum number and type of quality control tests shall be as follows:

- a. Optimum moisture, maximum density. [Two] [ ] of each type or change of material with in-place density requirements.
- b. Thickness, smoothness and uniformity. [Two] [ ] tests each day for every 1000 square yards [ ] or less mixed and placed.
- c. Field density. One set of [3] [ ] tests for each lift for every [2000] square yards [ ] or less.

[d. Field application rate test. One test for each lime spreading vehicle to be used on site.]

-- End of Section --



## SECTION 32 11 34

### PORTLAND CEMENT-STABILIZED BASE OR SUBBASE COURSE 08/08

#### PART 1 GENERAL

##### 1.1 UNIT PRICES

##### 1.1.1 Measurement

##### 1.1.1.1 Portland Cement Stabilization

Measurement shall be by the square yard of work completed and accepted.

##### 1.1.1.2 Cement

Measurement shall be by the number of short hundred-weight (cwt) of cement used in the completed and accepted work. No measurement shall be made for wasted cement or cement used in work determined defective.

##### 1.1.1.3 Bituminous Material

Bituminous material to be paid for shall be measured by the number of [gallons of the material used in the accepted work, corrected to gallons at 60 degrees F in accordance with (b) (7)(E)]. A coefficient of 0.00025 per degree F shall be used for asphalt emulsion [2000 pound tons of the material used in the accepted work].

##### 1.1.1.4 Select Material

Select material shall be measured by the [cubic yard] [2000 pound ton] of material placed and used in the completed and accepted stabilization. No measurement will be made for select material that is wasted or used in work determined defective.

##### 1.1.2 Payment

Cement stabilization, constructed and accepted, including cement, [bituminous material] [and select material] will be paid for at the respective contract unit prices in the bidding schedule. No payment will be made for any material wasted, used for the convenience of the Contractor, unused or rejected, or for water used. [Select material obtained from grading and excavation operations at the project site will not be paid for under this section but will be included for payment under other sections specifying grading and excavating.] [No separate payment will be made for sanding or dusting the bituminous prime-coated surfaces, and all costs for sanding or dusting will be included in the contract unit price for bituminous material.]

##### 1.1.3 Waybills and Delivery Tickets

Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all cement [, bituminous material] [and select material] used in the construction.

## 1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

(b) (7)(E)

#### 1.3 DEFINITION

Portland cement-stabilized base or subbase course, as used herein, is a mixture of portland cement and in-place, or select borrow, material uniformly blended and thoroughly compacted to produce a pavement course which meets the criteria set forth in the drawings and specifications.

#### 1.4 SYSTEM DESCRIPTION

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. Provide equipment with the capability of producing the required compaction, meeting grade controls, thickness control and smoothness requirements specified. [Place a test section of at least 8 by 100 feet, utilizing the equipment and procedures proposed for use by the Contractor, to demonstrate that soil-cement stabilization conforming to this specification can be produced] [A test section is not required].

#### 1.4.1 Central-Plant

Provide a central plant capable of producing a uniform cement-treated mixture at the required cement and moisture contents. Soil and cement shall be dry-mixed sufficiently to prevent cement balls from forming when water is added.

#### 1.4.2 Straightedge

Furnish and maintain at the site, in good condition, one [10] [12] foot straightedge for each bituminous paver, for use in the testing of the finished surface. Make straightedges available for Government use. Construct straightedges of aluminum or other lightweight metal with blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

#### 1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

##### SD-03 Product Data

Mix Design[; G][; G, [\_\_\_\_]]

Proposed mix design, prior to start of stabilization work.

Aggregate

Notification of sources from which aggregates are to be obtained, within 15 days after the award of contract.

Bituminous Material

Notification of sources from which bituminous materials are to be obtained, within 15 days after the award of the contract.

Waybills and Delivery Tickets

Copies during construction. Copies for all material used, before final payment.

##### SD-06 Test Reports

Aggregate

Certified copies of aggregate test results, not less than [30] [\_\_\_\_] days before the material is required in the work. Calibration curves and related test results, prior to using the device or equipment being calibrated.

##### SD-07 Certificates

Bituminous Material

Certified copies of the manufacturer's test reports indicating compliance with applicable specified requirements, not less than [30] [\_\_\_\_\_] days before the material is required in the work.

## 1.6 ENVIRONMENTAL REQUIREMENTS

Do not apply cement when the atmospheric temperature is less than 40 degrees F or to soils that are frozen or contain frost, or when the underlying material is frozen. If the temperature falls below 35 degrees F, protect completed cement-treated areas against detrimental effects of freezing. Any areas of completed [base] [or] [subbase] that are damaged by freezing, rainfall, or other weather conditions shall be brought to a satisfactory condition in conformance with this specification without additional cost to the Government.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Cement

Provide cement conforming to (b) (7)(E)

#### 2.1.2 Bituminous Material

Bituminous material shall conform to one of the following:

##### 2.1.2.1 Cutback Asphalt

(b) (7)(E)

##### 2.1.2.2 Emulsified Asphalt

(b) (7)(E)

##### 2.1.2.3 Tar

(b) (7)(E)

#### 2.1.3 Material to be Stabilized

Stabilize material using [in-place material] [select material conforming to (b) (7)(E)]. Remove stones retained on a 2 inch sieve and deleterious substances such as sticks, debris, and organic matter. When the in-place material consists primarily of soil having high plasticity or otherwise undesirable characteristics, construct the course to produce fully hardened soil cement as determined by (b) (7)(E)

#### 2.1.4 Water

Provide water which is clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other substances deleterious to the hardening of soil-cement, and subject to approval.

### 2.1.5 Burlap

Burlap shall conform to (b) (7)(E)

### 2.1.6 Impervious Sheeting

Sheeting shall conform to (b) (7)(E) and shall be white waterproof paper, white opaque polyethylene film or white burlap-polyethylene sheets.

## 2.2 MIX DESIGN

Develop the mix using the aggregate or soil-aggregate material to be stabilized. Mix shall have a minimum compressive strength of (b) (7)(E), a weight loss of (b) (7)(E)

## 2.3 SAMPLING AND TESTING

### 2.3.1 Testing Facilities

Perform sampling and testing using an approved commercial testing laboratory or by facilities furnished by the Contractor. Work requiring testing will not be permitted until the facilities have been inspected and approved. The first inspection will be at the expense of the Government. Cost incurred for any subsequent inspection, required because of failure of the facilities to pass the first inspection, will be charged to the Contractor. Perform tests in sufficient numbers, and as specified, to ensure that materials and compaction meet specified requirements. Furnish copies of the test results to the Contracting Officer within 24 hours of completion of tests.

### 2.3.2 Test Results

Results shall verify that materials comply with the specification. When a material source is changed, [test the new material for compliance] [\_\_\_\_\_]. When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or repaired to conform to the contract requirements at no additional cost to the Government.

### 2.3.3 Aggregate

Tests for determining the suitability of aggregate shall include, but not be limited to: sieve analysis in accordance with (b) (7)(E), and (b) (7)(E) using sieves conforming to (b) (7)(E), liquid limits and plasticity index in accordance with (b) (7)(E). Take aggregate samples for laboratory tests in accordance with (b) (7)(E). Prepare specimens to be used for unconfined compression tests in accordance with (b) (7)(E) except that a 4 inch diameter by 8 inch high mold shall be used to prepare specimens when more than (b) (7)(E).

### 2.3.4 Initial Sampling and Testing

#### 2.3.4.1 Laboratory Density

Conduct moisture-density tests in accordance with the procedure contained in (b) (7)(E); however the apparatus and procedures outlined in (b) (7)(E) shall be used to compact the soil-cement mixture.

#### 2.3.4.2 Unconfined Compression Testing

Conduct three unconfined compression tests, in accordance with (b) (7)(E), for each mix design tested. Cure samples at a constant moisture content and temperature for 7 days.

#### 2.3.4.3 Durability Tests

[Conduct wet-dry tests in accordance with (b) (7)(E) [Conduct freeze-thaw tests in accordance with (b) (7)(E).] Three tests shall be conducted for each mix design tested.

#### 2.3.5 Sieve Analysis

A minimum of one analysis shall be performed for each [1000] [\_\_\_\_\_]tons of material to be stabilized, with a minimum of 3 analyses for each day's run until the course is completed. When [the source of materials is changed] [and] [deficiencies] are found, the analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced at no additional cost to the Government.

#### 2.3.6 Liquid Limit and Plasticity Index

One liquid limit and plasticity index shall be performed for each sieve analysis. Liquid limit and plasticity index shall be in accordance with (b) (7)(E).

#### 2.3.7 Sampling and Testing During Construction

Perform quality control sampling and testing during construction as required in paragraph FIELD QUALITY CONTROL.

### PART 3 EXECUTION

#### 3.1 GENERAL REQUIREMENTS

Do not apply cement if the soil moisture content exceeds optimum moisture content specified for the cement-treated mixture. After mixing is completed, the proportions of the mixture shall be in accordance with the approved mix design. When application of water and mixing are completed, on the basis of dry weight, moisture shall not be below the optimum moisture content of the mixture nor shall it be more than 2 percent above the optimum moisture content. When the stabilized course is constructed in more than 1 layer, clean the previously constructed layer of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Provide adequate drainage during the entire construction period to prevent water from collecting or standing on the areas to be stabilized or on pulverized, mixed, or partially mixed material. Provide line and grade stakes as necessary for control. Place grade stakes in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

#### 3.2 OPERATION OF BORROW PITS

[Borrow pits shall be cleared, stripped and excavated to working depth in a manner that produces excavation faces that are as nearly vertical as practicable for the materials being excavated. Waste strata of unsuitable materials overlying or occurring in the deposit. Methods of operating the pits and the processing and blending of the materials may be changed or modified if necessary to obtain material conforming to the specified requirements. Upon completion of the work, condition pits to drain readily, and be left in a satisfactory condition.] [Obtain borrow material from approved offsite sources.]

### 3.3 STOCKPILING MATERIALS

Stockpile select material, including approved material available from excavation and grading, in the manner and at the locations designated. Before stockpiling of material, the storage sites shall be cleared, drained, and leveled. Materials obtained from different sources shall be stockpiled separately.

### 3.4 PREPARATION OF AREA TO BE STABILIZED

Area to be stabilized shall be cleaned of debris; inspected for adequate compaction; and shall be capable of withstanding, without displacement, the compaction specified for the soil-cement mixture. Debris and removed unsatisfactory in-place material shall be disposed of as specified.

#### 3.4.1 In-Place Material to be Stabilized

The entire area to be stabilized shall be graded and shaped to conform to the lines, grades, and cross sections shown in the plans, prior to being processed. Soft or yielding areas shall be made stable before construction is begun.

#### 3.4.2 In-Place Materials to Receive Stabilized Course

[Soft, yielding areas and ruts or other irregularities in the surface shall be corrected. Material in the affected areas shall be loosened and unsatisfactory material removed. Add approved select material where directed. The area shall then be shaped to line, grade, and cross section, and shall be compacted to the specified density.] [Subgrade shall conform to Section 31 00 00 EARTHWORK.] [Subbase course shall conform to Section 32 11 16.16 SUBBASE COURSES.]

#### 3.4.3 Select Material

Sufficient select material shall be utilized to provide the required thickness of the soil-cement layer after compaction and shall be processed to meet the requirements specified before cement stabilization is undertaken.

### 3.5 INSTALLATION

#### 3.5.1 Edges of Stabilized Course

Placed approved material along the edges of the stabilized course in such quantity as will compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple-layer course, allowing at least a 1 foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the stabilized course.

#### 3.5.2 Mixed-in-Place Method

##### 3.5.2.1 Scarifying and Pulverizing of Soil

Prior to the application of cement, the soil shall be scarified and pulverized [to the depth shown] [to a depth of [\_\_\_\_\_]inches]. Carefully control scarification so that the layer beneath the layer to be stabilized is not disturbed. Depth of pulverizing shall not exceed the depth of scarification. Unless otherwise permitted, the area scarified and pulverized shall not exceed the area that can be completed in 2 working days.



#### 3.5.2.2 Application of Cement

Approximately shape pulverized material to the cross section indicated. Cement shall be applied so that when uniformly mixed with the soil, the specified cement content is obtained, and a sufficient quantity of cement-treated soil is produced to construct a compacted cement-treated course conforming to the lines, grades, and cross section indicated. Equipment, except that used in spreading and mixing operations, shall not pass over the freshly spread soil cement.

#### 3.5.2.3 Dry Mixing

Immediately after the cement has been distributed, it shall be mixed with the soil. The cement shall not be mixed below the required depth. Continue mixing until the cement has been sufficiently blended with the soil to prevent the formation of cement balls when water is applied.

#### 3.5.2.4 Water Application and Moist Mixing

Determine moisture content of the mixture immediately after completion of mixing of the soil and cement. Provide water-supply and pressure distributing equipment that will permit the continuous application within 3 hours of all water required on the section being processed. Incorporate water in the mix so that concentration of water near the surface does not occur. After all the mixing water has been added, continue mixing until the water is uniformly distributed throughout the full depth of the mixture, with no portion of the mixture remaining undisturbed during mixing for more than 30 minutes. Any portion of the mixture remaining undisturbed more than 30 minutes during mixing shall be disposed of as specified. Satisfactory moisture distribution shall occur along the edges of the section.

#### 3.5.3 Central-Plant Method

Haul the mixture to the job in trucks equipped with protective covers. Thoroughly moisten the underlying course and deposit the material on the prepared area in a quantity that will produce a compacted base of uniform density to the required grade and cross section. Spreading or spreading-trimming equipment shall be constructed and operated to produce a layer of material which is uniform in thickness and surface contour and free from irregularities in density. Use spreading or spreading-trimming equipment in sufficient numbers and in staggered formation to obtain full-width spreading in 1 construction operation. Not more than 60 minutes shall elapse between the start of the moist mixing and the start of compaction of the treated layer. Not more than 30 minutes shall elapse between the placement of the cement-treated soil in adjacent lanes on 2-lane structures at any location.

#### 3.5.4 Traveling-Plant Method

Move traveling plant at a uniform rate of speed to accomplish thorough mixing of the materials. Deliver water and cement from supply trucks or bins at a predetermined rate. Windrows of prepared soil-cement mixture shall be of sufficient size to cover a predetermined width to the indicated compacted thickness.

#### 3.5.5 Layer Thickness

Compacted thickness of the stabilized course shall be [as indicated] [[\_\_\_\_\_]inches]. No layer shall be in excess of (b) (7)(E) in compacted thickness.

#### 3.5.6 Compaction

Before compaction operations are started and as a continuation of the mixing operation, the mixture shall be thoroughly loosened to the full depth. At the beginning of compaction, (b) (7)(E)

(b) (7)(E) . Start compaction immediately after mixing is completed. Density of compacted soil-cement mixture shall be at least [\_\_\_\_\_] percent of the maximum density obtained from the laboratory prepared samples. Loose mixture shall be uniformly and continuously compacted until the entire depth and width of the area are compacted to the density specified. The moisture content at the surface shall be maintained near optimum at all times through the rolling, but shall be less than that quantity which will cause the soil-cement mixture to become unstable during compaction. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Displacement of the mixture shall not occur due to the speed of the roller. Areas inaccessible to rollers shall be compacted with mechanical tampers.

### 3.6 FINISHING

The surface shall be moistened, if necessary, and shaped to the required lines, grades, and cross section. Lightly scarify the surface, if necessary, to eliminate any imprints made by the compacting or shaping equipment. The surface shall then be thoroughly compacted to the specified density with rubber-tired rollers and smooth-wheel tandem rollers to the extent necessary to provide a smooth, dense, uniform surface that is free of surface checking, ridges, or loose material, and that conforms to the crown, grade, and line indicated. Complete these finishing operations within 2 hours after completion of mixing operations. In places not accessible to finishing and shaping equipment, the mixtures shall be compacted with mechanical tampers to the density specified and shall be shaped and finished by hand methods. Correct, as specified below, any portion of the compacted mix that has density less than that specified, that has not properly hardened, or that is improperly finished.

### 3.7 CONSTRUCTION JOINTS

At the end of each day's construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face free of loose or shattered material. Material along construction joints not properly compacted shall be removed and replaced with soil-cement that is mixed, moistened, and compacted as specified.

### 3.8 CURING AND PROTECTION

Protect the finished surface against rapid drying for 7 days by one of the methods specified.

#### 3.8.1 Moist Curing

Apply a 2 inch covering of soil or not less than 4 pounds/square yard of straw. The material shall be moistened initially and kept moistened throughout the curing period. In multiple-layer construction, the soil used in moist curing, if of approved select material, may be used for constructing the succeeding stabilized course.

#### 3.8.2 Burlap

Provide burlap covers consisting of 2 or more layers of burlap having a combined weight of 14 ounces or more per square yard in a dry condition. Burlap shall be either new or shall have been used only for curing concrete. Burlap strips shall have a length, after shrinkage, at least 1 foot greater than necessary to cover the entire width and edges of the finished stabilized area. Mats shall overlap each other at least 6 inches. Mats shall be thoroughly wetted before placing and shall be kept continuously wet and in contact with the surface and edges of the finished stabilized area for the entire curing period.

#### 3.8.3 Impervious Sheeting

The surface of the finished stabilized area shall be moistened with a fine spray of water and then covered with impervious sheeting. The burlap of the polyethylene-coated burlap shall be thoroughly saturated with water before placing. Sheeting shall be placed with the light-colored side up. Sheets shall extend over the edges of the stabilized area and shall be held securely in place throughout the curing period. Edges of sheets shall overlap each other at least 12 inches and shall be securely cemented or taped to form continuous closed joints. Tears and holes in sheets shall be repaired immediately.

### 3.9 BITUMINOUS MATERIAL APPLICATION

Apply bituminous material uniformly by means of a bituminous distributor within a temperature range of [\_\_\_\_\_] to [\_\_\_\_\_] degrees F, as directed. Bituminous material for curing shall be uniformly applied at the rate of (b) (7)(E). Areas inaccessible to or missed by the distributor shall be properly treated using the manually operated hose attachment. Bituminous material shall be applied only to the top layer. At the time the bituminous material is applied, the surface shall be free of loose or foreign matter and shall contain sufficient moisture to prevent excessive penetration of the bituminous material. When necessary, water in sufficient quantity to fill the surface voids shall be applied immediately before the bituminous material is applied. Treated surface shall be sanded or dusted to prevent the bituminous material from being picked up by traffic.

### 3.10 FIELD QUALITY CONTROL

#### 3.10.1 Grade Control

Underlying material shall be excavated to sufficient depth for the required stabilized-course thickness. The finished stabilized course with the subsequent surface course shall meet the fixed grade. Finished and completed stabilized area shall conform to the lines, grades, cross section, and dimensions indicated.

#### 3.10.2 Smoothness Test

The surface of a stabilized layer shall show no deviations in excess of 3/8 inch when tested with the straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing new material, or by reworking existing material and compacting, as directed. Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a straightedge. Measurements shall also be taken perpendicular to the road centerline at [50] [\_\_\_\_\_] foot intervals.

#### 3.10.3 Thickness Control

The completed thickness of the stabilized course shall be within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, such areas shall be corrected by scarifying, adding mixture of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course shall be considered as conforming with the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated. The thickness of the stabilized course shall be measured at intervals which ensure one measurement for each [500] [\_\_\_\_\_] square yards of stabilized course. Measurements shall be made in 3 inch diameter test holes penetrating the stabilized course.

#### 3.10.4 Testing

Perform field tests in sufficient numbers to assure that the specifications are being met. Testing is the responsibility of the Contractor and shall be performed by an approved commercial laboratory.

### 3.10.5 Field Density

Field density tests shall be performed in accordance with (b) (7)(E) results in a wet unit weight of soil and (b) (7)(E) shall be used to determine the moisture content of the soil. Calibration curves furnished along with the density gauge shall be checked as described in (b) (7)(E). Calibration checks of the density gauge shall be made at the beginning of a job on each type of material encountered. If (b) (7)(E) is used, in-place densities shall be checked by (b) (7)(E) at least once per lift for each [ ] square yard of stabilized material. Calibration curves and calibration test results shall be furnished within 24 hours of conclusion of the tests. At least 1 field density test shall be performed for each (b) (7)(E) [ ] square yards of each layer of base material.

### 3.10.6 Samples of Bituminous Materials

Obtain under the supervision of the Contracting Officer a sample of the bituminous material used. The sample will be retained by the Government.

### 3.10.7 Maintenance

Maintain the stabilized area in a satisfactory condition until the completed work is accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Defects shall be remedied as specified.

### 3.10.8 Traffic

Completed portions of the cement-treated soil area may be opened immediately to light traffic provided the curing is not impaired. After the curing period has elapsed, completed areas may be opened to all traffic provided that the cement-stabilized course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. Heavy equipment will not be permitted on the area during the curing period. Cement and water may be hauled over the area with pneumatic-tired equipment as approved. Finished portions of cement-stabilized soil that are traveled on by equipment used in constructing an adjoining section shall be protected in a manner that prevents equipment from marring or damaging the completed work.

## 3.11 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials, that are unsuitable for stabilization, material that is removed for the required correction of defective areas, waste material, and debris shall be disposed of [as directed] [in disposal area indicated].

-- End of Section --

SECTION 32 12 10

BITUMINOUS TACK AND PRIME COATS  
o8/o8

PART 1 GENERAL

1.1 UNIT PRICES

1.1.1 Measurement

The bituminous material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10 percent over the specified application rate. Any amount of bituminous material more than 10 percent over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas where hand spraying of the bituminous material is necessary. Express measured quantities in [2000 pound tons] [gallons at 60 degrees F. Volumes measured at temperatures other than 60 degrees F shall be corrected [in accordance with (b) (7)(E) [using a coefficient of expansion of 0.00025 per degree F for asphalt emulsion]].

1.1.2 Payment

The quantities of bituminous material, determined as specified above, will be paid for at the respective contract unit prices. Payment shall constitute full compensation for all operations necessary to complete the work as specified herein.

1.1.3 Waybills and Delivery Tickets

Submit waybills and delivery tickets, during progress of the work. Before the final statement is allowed, file with the Contracting Officer certified waybills and certified delivery tickets for all bituminous materials used in the construction of the pavement covered by the contract. These submittals are required for Unit Pricing bid only. Do not remove bituminous material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

(b) (7)(E)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

U.S. GREEN BUILDING COUNCIL (USGBC)

(b) (7)(E)

### 1.3 SYSTEM DESCRIPTION

#### 1.3.1 General Requirements

Plant, equipment, machines and tools used in the work are subject to approval and shall be maintained in a satisfactory working condition at all times. Calibrated equipment such as asphalt distributors, scales, batching equipment, spreaders and similar equipment, should have been recalibrated by a calibration laboratory within [12] [\_\_\_\_\_] months prior to commencing work [and every [\_\_\_\_\_] months thereafter, by such laboratory from the date of recalibration, during the term of the contract].

#### 1.3.2 Bituminous Distributor

Provide a distributor with pneumatic tires of such size and number that the load produced on the base surface does not exceed 650 psi of tire width to prevent rutting, shoving or otherwise damaging the base surface or other layers in the pavement structure. Design and equip the distributor to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates from (b) (7)(E)

Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. Equip the distributor to circulate and agitate the bituminous material during the heating process.

#### 1.3.3 Heating Equipment for Storage Tanks

The equipment for heating the bituminous material shall be steam, electric, or hot oil heaters. Provide steam heaters consisting of steam coils and equipment for producing steam, so designed that the steam cannot get into the material. Fix an armored thermometer to the tank with a temperature range from 40 to 400 degrees F so that the temperature of the bituminous material may be determined at all times.

#### 1.3.4 Power Brooms and Power Blowers

Use power brooms and power blowers suitable for cleaning the surfaces to which the bituminous coat is to be applied.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Waybills and Delivery Tickets

Local/Regional Materials

SD-06 Test Reports

Sampling and Testing

#### 1.5 QUALITY ASSURANCE

[Use Local/Regional Materials or products extracted, harvested, or recovered, as well as manufactured, within a [500] [ ] mile radius from the project site, if available from a minimum of three sources.] [See Section (b) (7)(E) DOCUMENTATION for cumulative total local material requirements. Tack and prime coat materials may be locally available.] [Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project in accordance with LEED.]

## 1.6 DELIVERY, STORAGE, AND HANDLING

Inspect the materials delivered to the site for contamination and damage. Unload and store the materials with a minimum of handling.

## 1.7 ENVIRONMENTAL REQUIREMENTS

Apply bituminous coat only when the surface to receive the bituminous coat is dry. Apply bituminous coat only when the atmospheric temperature in the shade is 50 degrees F or above and when the temperature has not been below 35 degrees F for the 12 hours prior to application, unless otherwise directed.

## PART 2 PRODUCTS

### 2.1 PRIME COAT

Provide asphalt conforming to (b) (7)(E) Grade [\_\_\_\_] and specified in the following two subparagraphs.

#### 2.1.1 Cutback Asphalt

Provide cutback asphalt conforming to (b) (7)(E).

#### 2.1.2 Emulsified Asphalt

Provide emulsified asphalt conforming to (b) (7)(E).

### 2.2 TACK COAT

Provide asphalt conforming to (b) (7)(E) Grade [\_\_\_\_].

#### 2.2.1 Cutback Asphalt

Provide cutback asphalt conforming to (b) (7)(E).

#### 2.2.2 Emulsified Asphalt

Provide emulsified asphalt conforming to (b) (7)(E). Dilute the emulsified asphalt with equal parts of water. The base asphalt used to manufacture the emulsion shall show a negative spot when tested in accordance with (b) (7)(E) using (b) (7)(E).

## PART 3 EXECUTION

### 3.1 PREPARATION OF SURFACE

Immediately before applying the bituminous coat, remove all loose material, dirt, clay, or other objectionable material from the surface to be treated by means of a power broom or blower supplemented with hand brooms. The surface shall be dry and clean at the time of treatment.



### 3.2 APPLICATION RATE

The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contracting Officer.

#### 3.2.1 Tack Coat

Apply bituminous material for the tack coat in quantities of not less than 0.05 gallon nor more than 0.15 gallon per square yard of pavement surface.

#### 3.2.2 Prime Coat

Apply bituminous material for the prime coat in quantities of not less than 0.18 gallon nor more than 0.35 gallon per square yard of pavement surface.

### 3.3 APPLICATION TEMPERATURE

#### 3.3.1 Viscosity Relationship

Asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 centistokes, kinematic. Furnish the temperature viscosity relation to the Contracting Officer.

#### 3.3.2 Temperature Ranges

The viscosity requirements determine the application temperature to be used. The following is a normal range of application temperatures:

Liquid Asphalts

-----  
(b) (7)(E)  
-----

Paving Grade Asphalts

Penetration Grades

-----  
(b) (7)(E)  
-----

Viscosity Grades

(b) (7)(E)

Emulsions

(b) (7)(E)

These temperature ranges exceed the flash point of the material and care should be taken in their heating.

### 3.4 APPLICATION

#### 3.4.1 General

Following preparation and subsequent inspection of the surface, apply the bituminous prime or tack coat with the Bituminous Distributor at the specified rate with uniform distribution over the surface to be treated. Properly treat all areas and spots missed by the distributor with the hand spray. Until the succeeding layer of pavement is placed, maintain the surface by protecting the surface against damage and by repairing deficient areas at no additional cost to the Government. If required, spread clean dry sand to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are a part of the equipment are permitted within 25 feet of heating, distributing, and transferring operations of bituminous material other than bituminous emulsions. Prevent all traffic, except for paving equipment used in constructing the surfacing, from using the underlying material, whether primed or not, until the surfacing is completed. The bituminous coat shall conform to all requirements as described herein.

#### 3.4.2 Prime Coat

[Apply a prime coat at locations shown on the Drawings.] [The prime coat is required if it will be at least [7] [\_\_\_\_] days before the surfacing (Asphalt cement hot mix concrete) layer is constructed on the underlying (base course, etc.) compacted material. The type of liquid asphalt and application rate will be as specified herein. Protect the underlying from any damage (water, traffic, etc.) until the surfacing is placed. If the Contractor places the surfacing within seven days, the choice of protection measures or actions to be taken is at the Contractor's option. Repair (recompact or replace) damage to the underlying material caused by lack of, or inadequate, protection by approved methods at no additional cost to the Government. If the Contractor opts to use the prime coat, apply as soon as possible after consolidation of the underlying material.] Apply the bituminous material uniformly over the surface to be treated at (b) (7)(E) rate shall be as specified above in paragraph APPLICATION RATE. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, spread building paper on the surface for a sufficient distance back from the ends of each application to start and stop the prime coat on the paper and to

ensure that all sprayers will operate at full force on the surface to be treated. Immediately after application remove and destroy the building paper.

#### 3.4.3 Tack Coat

Apply tack coat at the locations shown on the drawings. Apply the tack coat when the surface to be treated is dry. Immediately following the preparation of the surface for treatment, apply the bituminous material by means of the bituminous distributor, within the limits of temperature specified herein and at a rate as specified above in paragraph APPLICATION RATE. Apply the bituminous material so that uniform distribution is obtained over the entire surface to be treated. Treat lightly coated areas and spots missed by the distributor with the bituminous material. Following the application of bituminous material, allow the surface to cure without being disturbed for period of time necessary to permit setting of the tack coat. Apply the bituminous tack coat only as far in advance of the placing of the overlying layer as required for that day's operation. Maintain and protect the treated surface from damage until the succeeding course of pavement is placed.

#### 3.5 CURING PERIOD

Following application of the bituminous material and prior to application of the succeeding layer of pavement, allow the bituminous coat to cure and to obtain evaporation of any volatiles or moisture. Maintain the coated surface until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas. [Allow the prime coat to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course. Furnish and spread enough sand to effectively blot up and cure excess bituminous material.]

#### 3.6 FIELD QUALITY CONTROL

Samples of the bituminous material [shall be tested for compliance with the applicable specified requirements. A sample shall be obtained and tested by the Contractor for every [(\_\_\_\_)tons] [(\_\_\_\_)gallons] of bituminous material used] [used shall be obtained by the Contractor as directed, under the supervision of the Contracting Officer. The sample may be retained and tested by the Government at no cost to the Contractor].

#### 3.7 SAMPLING AND TESTING

Submit copies of all test results for emulsified asphalt, and bituminous materials, within 24 hours of completion of tests. Furnish certified copies of the manufacturer's test reports indicating temperature viscosity relationship for cutback asphalt, compliance with applicable specified requirements, not less than [30] [(\_\_\_\_) days before the material is required in the work. Perform sampling and testing by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved.

##### 3.7.1 Sampling

The samples of bituminous material, unless otherwise specified, shall be in accordance with (b) (7)(E) [REDACTED] Sources from which bituminous materials are to be obtained shall be selected and notification furnished the Contracting Officer within 15 days after the award of the contract.

##### 3.7.2 Calibration Test

Furnish all equipment, materials, and labor necessary to calibrate the bituminous distributor. Calibration shall be made with the approved job material and prior to applying the bituminous coat material to the prepared surface. Calibrate the bituminous distributor in accordance with (b) (7)(E).

### 3.7.3 Trial Applications

Before providing the complete bituminous coat, apply three lengths of at least 100 feet for the full width of the distributor bar to evaluate the amount of bituminous material that can be satisfactorily applied.

#### 3.7.3.1 Tack Coat Trial Application Rate

Unless otherwise authorized, apply the trial application rate of bituminous tack coat materials in the amount of 0.05 gallons per square yard. Other trial applications shall be made using various amounts of material as may be deemed necessary.

#### 3.7.3.2 Prime Coat Trial Application Rate

Unless otherwise authorized, apply the trial application rate of bituminous materials in the amount of 0.25 gallon per square yard. Other trial applications shall be made using various amounts of material as may be deemed necessary.

### 3.7.4 Sampling and Testing During Construction

Perform quality control sampling and testing as required in paragraph FIELD QUALITY CONTROL.

## 3.8 TRAFFIC CONTROLS

Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

-- End of Section --

SECTION 32 12 18

RESIN MODIFIED PAVEMENT SURFACING MATERIAL  
08/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

(b) (7)(E)

ASTM INTERNATIONAL (ASTM)

(b) (7)(E)

(b) (7)(E)

U.S. ARMY CORPS OF ENGINEERS (USACE)

(b) (7)(E)

## 1.2 SYSTEM DESCRIPTION

### 1.2.1 Asphalt Mixing Plant

Provide a bituminous asphalt plant with enough capacity to produce the quantities of bituminous mixtures required for the project and conforming to the requirements of (b) (7)(E), with the following changes:

- a. Testing Facilities. Provide laboratory facilities at the plant for the use of the Government's acceptance testing and the Contractor's quality control testing.
- b. Storage Bins. Use of storage bins for temporary storage of hot-mix asphalt will be permitted as follows:
  - (1) The asphalt mixture may be stored in insulated storage bins for a period of time not exceeding 1 hour.

(2) Provide hauling equipment, paving machines, rollers, miscellaneous equipment, and tools in sufficient numbers, capacity and in proper working condition to place the asphalt paving mixtures at a rate equal to the plant output.

#### 1.2.2 Asphalt Paver

Provide asphalt pavers which are self-propelled, with a vibrating screed, heated as necessary, and capable of spreading and finishing courses of hot-mix asphalt meeting the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.

#### 1.2.3 Receiving hopper

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

#### 1.2.4 Automatic Grade Control

If an automatic grade control device is used, equip the paver with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line and/or through a system of mechanical sensors, or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. The transverse slope controller shall not be used to control grade. The controls shall be capable of working in conjunction with any of the following attachments:

- a. Ski-type device of not less than 30 feet in length.
- b. Taut stringline set to grade.
- c. Short ski or shoe for joint matching.
- d. Laser control.

#### 1.2.5 Slurry Grout

The additional requirements for production of slurry grout for the Resin Modified Pavement (RMP) are a concrete batch plant, a ready mix truck, or portable mixer for grout mixing, and small 2 ton (maximum) tandem steel wheeled vibratory roller for compaction of RMP.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.][information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Open Graded Asphalt Job Mix Formula

## Job Mix Formula for Slurry Grout

Materials required to produce the open graded asphalt mixture and slurry grout job-mix-formulas in the quantities indicated below.

Aggregates representing each stockpile to be used in the production of the open-graded asphalt mixture: 100 pounds each

Bituminous Material (b) (7)(E)  
Slurry Grout Sand (b) (7)(E)  
Fly Ash (b) (7)(E)  
Cement (b) (7)(E)  
Cross Polymer Resin (b) (7)(E)

Along with the Contractor's preliminary job mix formulas, deliver samples, 30 days before starting production, to U.S. Army Engineer Waterways Experiment Station Research and Development Center, 3909 Halls Ferry Road, Vicksburg, Mississippi, 39180-6199, ATTN:

(b) (6), (b) (7)(C)

## SD-o6 Test Reports

Coarse Aggregate[; G][; G, [\_\_\_\_]]  
Coarse and Fine Aggregates[; G][; G, [\_\_\_\_]]  
Open-Graded Mix Aggregate[; G][; G, [\_\_\_\_]]  
Bituminous Material[; G][; G, [\_\_\_\_]], [\_\_\_\_]  
Slurry Grout Sand[; G][; G, [\_\_\_\_]]  
Filler (Fly Ash)[; G][; G, [\_\_\_\_]]  
Job Mix Formula for Slurry Grout[; G][; G, [\_\_\_\_]]  
Contractor Quality Control[; G][; G, [\_\_\_\_]]

Aggregate and QC test results. Conduct slurry grout viscosity tests immediately prior to application on the pavement surface and 30 minutes thereafter.

## SD-o7 Certificates

Cement[; G][; G, [\_\_\_\_]]  
Cross Polymer Resin[; G][; G, [\_\_\_\_]]  
Curing Compound[; G][; G, [\_\_\_\_]]

Copies of certificates.

## 1.4 QUALITY ASSURANCE

Provide the Contracting Officer access at all times, to all parts of the bituminous plant, for checking adequacy of any equipment in use; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking temperatures maintained in preparation of the mixtures.

### 1.4.1 Aggregates

#### 1.4.1.1 Sampling and Testing

Use (b) (7)(E) in sampling coarse and fine aggregates. Points of sampling will be designated by the Contracting Officer. Make all tests necessary to determine compliance with the specified requirements, using a Corps of Engineers certified Commercial Laboratory.



#### 1.4.1.2 Sources

Select sources of aggregates well in advance of the time when the materials are required in the work. Submit samples 30 days before starting production. If a sample of material fails to meet the specified requirements, replace the material represented by the sample, and the cost of testing the replaced sample shall be at the Contractor's expense. Approval of the source of the aggregate does not relieve the Contractor of the responsibility to deliver aggregates that meet the specified requirements.

#### 1.4.2 Bituminous Materials

Obtain samples of bituminous materials in accordance with (b) (7)(E). Select sources well in advance of the time materials will be required for the work. In addition to the initial qualification, samples shall be obtained and tested before and during construction when shipments of bituminous materials are received, or when necessary to assure that some condition of handling or storage has not been detrimental to the bituminous material.

### 1.5 DELIVERY, STORAGE, AND HANDLING

#### 1.5.1 Mineral Aggregates

Deliver mineral aggregates to the site of the bituminous mixing plant and stockpile them in such a manner as to preclude segregation or contamination with objectionable material.

#### 1.5.2 Bituminous Materials

Maintain bituminous materials below a temperature of 300 degrees F during storage without heating by the application of a direct flame to the walls of storage tanks or transfer lines. Thoroughly clean storage tanks, transfer lines and weigh buckets before a different type or grade of bitumen is introduced into the system.

#### 1.5.3 Slurry Grout Sand

Store slurry grout sand at the grout production site to prevent contamination with foreign materials and saturation with rain water. Determine moisture content of this sand just prior to grout production so that corrections to the job mix formula water content can be made to compensate for any moisture in the sand.

#### 1.5.4 Cementitious Materials

The temperature of the cementitious materials, as delivered for storage at the site, shall not exceed 150 degrees F.

#### 1.5.5 Open Graded Bituminous Mixture

Do not store the open graded bituminous mixture for longer than one hour prior to hauling to the job site.

### 1.6 ENVIRONMENTAL REQUIREMENTS

The bituminous mixture shall not be placed upon a wet surface, in rain, or when the surface temperature of the underlying course is less than 50 degrees F. Once the bituminous mixture has been placed, and if rain is imminent, place protective materials consisting of rolled polyethylene sheeting at least 4 mils

thick, of sufficient length and width to cover the mixture. If the open graded bituminous mixture becomes saturated, allow the pavement voids to thoroughly dry out prior to applying the slurry grout.

## PART 2 PRODUCTS

### 2.1 AGGREGATE

Provide aggregate consisting of (b) (7)(E)  
(b) (7)(E)  
(b) (7)(E)  
Conduct sieve analysis of coarse and fine aggregates in accordance with (b) (7)(E)

#### 2.1.1 Coarse Aggregate

Provide coarse aggregate consisting of sound, tough, durable particles, free from adherent films of matter that would prevent thorough coating with the bituminous material. The percentage of wear shall not be (b) (7)(E) when tested in accordance with (b) (7)(E). The magnesium sulfate soundness loss shall not (b) (7)(E), after five cycles, when tested in accordance with (b) (7)(E). Provide aggregate containing at (b) (7)(E) by weight of crushed pieces having two or more fractured faces. The area of each fractured face shall be (b) (7)(E) mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be (b) (7)(E). Obtain fractured faces by artificial crushing.

#### 2.1.2 Crushed Aggregates

Particle shape of crushed aggregates shall be essentially cubical. Quantity of flat (b) (7)(E)  
(b) (7)(E), when determined in accordance with (b) (7)(E).

#### 2.1.3 Open-Graded Mix Aggregate

The gradations in Table I represent the limits which shall determine the suitability of open-graded mix aggregate for use from the sources of supply. The aggregate, as finally selected, shall have a gradation within the limits designated in Table I and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be uniformly graded from coarse to fine.

TABLE I

#### OPEN GRADED MIX AGGREGATE

Sieve Size	Percent by Weight Passing
------------	---------------------------

(b) (7)(E)	
------------	--

Table I is based on aggregates of uniform specific gravity; the percent passing various sieves may be changed by the Contracting Officer when aggregates of varying specific gravities are used. Adjustments

of percentages passing various sieves may be directed by the Contracting Officer when aggregates vary more than 0.2 in specific gravity.

#### 2.1.4 Slurry Grout Sand

Provide slurry grout sand consisting of clean, sound, durable, particles of processed silica sand that meet the requirements for wear and soundness specified for coarse aggregate. The sand shall contain no clay, silt, or other objectionable matter. The gradations in Table II represent the limits which will determine the suitability of silica sand for use from the sources of supply.

TABLE II

#### FINE SAND FOR SLURRY GROUT

Sieve Size	Percent by Weight Passing
------------	---------------------------

(b) (7)(E)	
------------	--

The sand gradations shown are based on sand of uniform specific gravity, and the percentages passing the various sieves will be subject to appropriate correction by the Contracting Officer when aggregates of varying specific gravities are used.

#### 2.1.5 Filler (Fly Ash)

Provide fly ash having (b) (7)(E) and conforming to (b) (7)(E) requirements.

#### 2.2 BITUMINOUS MATERIAL

Provide bituminous material conforming to the requirements of (b) (7)(E) with a viscosity grade (b) (7)(E) and an original penetration of (b) (7)(E) Performance Grade (PG) [\_\_\_\_].

#### 2.3 CEMENT

The cement used in the slurry grout shall be portland cement conforming to (b) (7)(E).

#### 2.4 CROSS POLYMER RESIN

Utilize a cross polymer resin of (b) (7)(E), as a (b) (7)(E) producing agent. After mixing the resin into the slurry grout, the mixture shall have a viscosity which would allow it to flow from a Marsh Cone in accordance with Table III. A Marsh cone has dimensions of 6-1/8 inches base inside diameter, tapering 12-3/8 inches to a tip inside diameter of 3/8 inches. The 3/8 inch diameter neck shall have a length of 2-3/8 inches.

TABLE III

#### SLURRY GROUT VISCOSITY



#### 2.6.1.2 Specimen Production

Using the five mix design asphalt contents, produce three 4 inch diameter Marshall specimens at each asphalt content. Use approximately 1.8 lbs of combined aggregates following the previously determined aggregate blending formula for each specimen. Just before mixing, the temperature of the aggregates should be  $290 \pm 9^\circ\text{F}$  and the asphalt cement should be  $275 \pm 9^\circ\text{F}$ . With normal mixing procedures, the temperature of the asphalt mixture during compaction is  $250 \pm 9^\circ\text{F}$ . Compact the open-graded asphalt concrete specimens with 25 blows from a 10 lbs Marshall hand hammer on one side of each specimen. Allow the specimens to air cool for a minimum of 4 hours before carefully removing from molds.

#### 2.6.1.3 Measuring voids total mix (VTM)

- a. Measure the VTM of each open-graded specimen using the following formula:

$$\text{VTM} = \frac{\text{WT}_{\text{AIR}} - \text{Volume} \times \text{D} \times \text{H}}{\text{SGT}} \times 100$$

where

$$\begin{aligned} \text{WT}_{\text{AIR}} &= \text{Weight of air-dried specimen} \\ \text{Volume} &= \text{Volume of specimen} \\ \text{D} &= \text{Density of aggregate} \\ \text{H} &= \text{Density of asphalt cement} \\ \text{SGT} &= \text{Specific Gravity of aggregate} \end{aligned}$$

- b. Calculate the average VTM for each of the five asphalt cement contents. Select the optimum asphalt content as that which resulted in a VTM value closest to 30.0 percent. If no VTM averages are in the 30.0 percent range, then make adjustments to the aggregate gradation to achieve the proper void content. Optimum asphalt contents resulting in average VTM values in the 25 to 35 percent range are acceptable, but due to normal production and construction variations, the JMF shall be based on a mix design that provides a 28 to 32 percent VTM value is required. Typical optimum asphalt contents are between 3.5 and 4.5 percent.

#### 2.6.1.4 Job-Mix Formula Submittal

- a. The open-graded asphalt concrete job-mix formula will consist of the following information:

- (1) Percentage of each aggregate stockpile.
- (2) Percentage passing each sieve size for the blended aggregate.
- (3) Percentage of bitumen.
- (4) Temperature of discharged asphalt mixture.
- (5) Voids total mix percentage.

- b. The target temperature of the asphalt mixture when it is discharged from the mixing plant should be  $257 \pm 9^\circ\text{F}$ . Adjust the temperature depending on the ambient temperatures and the haul distance from the asphalt plant to the job site to meet the lay-down temperature.

#### 2.6.2 Job Mix Formula for Slurry Grout

Furnish the Job-Mix Formula (JMF) for the slurry grout for approval by the Government. Develop the slurry grout job mix formula using the proportions given in Table V.

TABLE V

## RESIN MODIFIED CEMENT SLURRY GROUT MIXTURE PROPORTIONS

Material	Percent by Weight
Silica Sand	(b) (7)(E)
Fly Ash	
Water	
Portland Cement	
Cross Polymer Resin	

Approximately 22 to 28 pounds of mixed slurry grout will fill in (b) (7)(E) open graded bituminous mixture with (b) (7)(E) percent voids total mix.

### 2.6.2.1 Initial Laboratory Procedure

- a. Minimum sample size is 51 lbs for cement, sand, and fly ash; and is 1 gal for resin additive.
- b. Using the grout material proportions specified in Table V, develop a matrix of initial job-mix formulas for laboratory viscosity testing. The goal of the grout mix design is to produce a material formulation, which results in a field Marsh Flow Cone viscosity of 8.0 to 10.0 seconds. The initial formulations shall ensure that a grout formulation can be produced with a Marsh viscosity no greater than the 10.0 seconds maximum. This is accomplished by testing grout formulations with relatively high w/c ratios and the maximum allowable amount of resin additive.
- c. The grout's w/c ratio shall be between 0.65 to 0.75, unless approved by the Contracting Officer. Higher w/c ratios are sometimes necessary to produce grout with Marsh Flow viscosity less than the 10.0-second maximum value. Therefore, the focus of the initial grout viscosity tests is to determine the minimum W/C ratio that will produce a grout viscosity less than or equal to 10.0 seconds. The resin additive serves as a plasticizer which reduces grout viscosity while reducing the amount of water required.
- d. The standard laboratory grout batch size should be in the 9 to 11 lbs range. Calculate the material batch weights based on the desired proportions. Multiple grout viscosity tests are facilitated by first blending the dry ingredients (cement, sand, fly ash) for each test sample and then adding the appropriate amount of water and resin additive during the mixing process. These dry ingredient batches should be kept in air-tight containers to prevent loss of material or contamination before mixing. Replicate two samples per blend for grout viscosity testing.

### 2.6.2.2 Mixing

- a. The equipment needed to effectively mix the resin grout includes a laboratory mixer equipped with a wire whip mixing attachment and approximately 2.5 gal capacity mixing bowl, a calibrated set of weight scales, and various small containers to weigh and transfer mix water and resin additive.
- b. Place dry ingredients into mixing bowl and adjust the bowl height so that the wire whip is just off of or touching the bottom and the sides of the bowl. Begin mixing the dry ingredients at a slow speed and immediately add the appropriate amount of water. Once all of the water is added, speed up the mixer to a point where the grout is being thrown onto the sides of the mixing bowl. Mix the grout at this high speed for 5 minutes, then add the appropriate amount of resin additive. Mix the

grout again at a high mixing speed for an additional 3 minutes before testing for Marsh Flow viscosity.

#### 2.6.2.3 Viscosity Testing

a. The equipment needed to measure grout viscosity includes a Marsh Flow Cone, a 0.25 gal glass or clear plastic graduated cylinder beaker, a 0.38 gal (approximately) empty beaker or bucket, and a stopwatch.

b. Immediately after mixing the grout, transfer the grout from the mixing bowl to the empty beaker or bucket. Take note of any lumps of material or excess sand in the bottom of the mixing bowl. Excess lumps indicate inadequate mixing and render the grout useless for viscosity testing. Immediately fill the Marsh Flow Cone with about 0.28 gal of grout. A consistent head of grout in the flow cone is achieved for all viscosity tests by marking an 0.28 gal fill line inside the flow cone. The flow cone outlet is plugged by simply placing one's finger over the outlet opening. Immediately after the flow cone is filled to the 0.28 gal fill line, position the cone over the 0.25 gal graduated beaker. Release the grout opening and start the stopwatch timer simultaneously. Measure the time of flow for 0.25 gal of grout from the flow cone to the nearest tenth of a second.

c. Record each test sample's viscosity, averaging the two replicates for each blend. Adjust the grout mix proportions as needed with the following considerations:

(1) Any grout viscosity between [REDACTED] (b) (7)(E) is acceptable. It should be noted; however, that when field construction temperatures are expected to be comparatively high (greater than 90°F) and/or the open-graded asphalt concrete voids are expected to be considerably low (less than 30 percent), then lower viscosity grouts will help to ensure easy grout application and full grout penetration. In most cases, these variables are unknown; therefore, it is prudent to select the grout formulation which has the lowest viscosity.

(2) Select a grout job-mix formula with water and resin additive contents below the maximum allowable limits to allow the Contracting Officer Representative to approve small additions of these ingredients in the field if necessary to meet viscosity requirements.

(3) Low w/c ratios shall be selected, within the viscosity criteria, to produce grout with higher strengths; reduce the chances for drying shrinkage cracking; and produce grout which is more consistent and better able to keep the sand in suspension during mixing and placement.

(4) When the sand is noted to settle out of solution during or immediately after mixing, the JMF shall be adjusted by reducing the amount of sand and increasing the amount of fly ash (both within the specified tolerances).

(5) If the viscosity requirements cannot be met, change the source of materials. Typical problems to investigate include the following: grout sand which is too coarse, portland cement which is highly reactive during the early stages of the hydration process, fly ash with excess cementitious nature.

#### 2.6.2.4 Job-Mix Formula Submittal

The grout job-mix formula will consist of the following information:

(1) Percentage (by weight) of each mixture ingredient rounded to the nearest tenth of a percent.

- (2) Type and source of portland cement.
- (3) Source of fly ash, silica sand, and resin additive.
- (4) Marsh Flow Cone viscosity of job-mix-formula grout.

## PART 3 EXECUTION

### 3.1 PREPARATION OF OPEN GRADED MIXTURES

Regulate rates of feed of aggregates so that moisture content and temperature of aggregates will be within tolerances specified. Convey aggregates and bitumen into the mixer in proportionate quantities required to meet the JMF. Mixing time shall be as required to obtain a uniform coating of the aggregate with the bituminous material. Temperature of bitumen at time of mixing shall not exceed 275 degrees F. Temperature of aggregate in the mixer shall not exceed 300 degrees F when bitumen is added. Reject overheated and carbonized mixtures or mixtures that foam.

### 3.2 WATER CONTENT OF AGGREGATES

Reduce the water content of mixture to less than 0.75 percent by drying operations. Determine water content in accordance with (b) (7)(E); weight of sample shall be at least 500 grams. Report the water content as a percentage of the total mixture.

### 3.3 TRANSPORTATION OF MIXTURE

Accomplish transportation from the mixing plant to the job site by trucks having tight, clean, smooth beds lightly coated with an approved releasing agent to prevent adhesion of mixture to truck bodies. Diesel fuel shall not be used as a releasing agent. Drain excessive release agent prior to loading. Cover each load with canvas or other approved material of ample size to protect mixture from the weather and to prevent loss of heat. Loads that have crusts of cold, unworkable material or have become wet will be rejected. Hauling over freshly placed material will not be permitted.

### 3.4 TEST SECTION

Prior to full production, and in the presence of the Contracting Officer, prepare and place a quantity of open graded bituminous mixture and slurry grout according to the JMF. The test section shall be a minimum of 100 feet long and 20 feet wide placed in one section and of the same depth specified for the construction of the course which it represents. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section. The test section shall meet the requirements specified in paragraph ACCEPTABILITY OF WORK. If the test section should fail to meet these requirements, make the necessary adjustments to the mix design, plant operation, and/or construction procedures. Construct additional test sections, as required, and evaluate them for conformance to the specifications at the Contractor's expense. A representative for the resin manufacturer shall be on site during the test section construction and during the initial placement.

### 3.5 SURFACE PREPARATION OF UNDERLYING COURSE

Prior to placing of open graded bituminous mixture, clean the underlying course of all foreign or objectionable matter with power brooms and hand brooms.



### 3.6 TACK COATING

Immediately before placing open-graded asphalt mix, spray contact surfaces of previously constructed pavement with a coat of bituminous material as specified in Section 32 12 10 BITUMINOUS TACK AND PRIME COATS.

### 3.7 PLACING OPEN GRADED BITUMINOUS MIXTURE

Place the mix at a temperature of not less than 175 degrees F. Upon arrival, spread the mixture to the full width ((b) (7)(E) ) by a bituminous paver. Strike off the mix in a uniform layer to a depth that, when the work is completed, will produce the required thickness indicated. Regulate the speed of the paver to eliminate pulling and tearing of the bituminous mat. Unless otherwise directed, begin placement of the mixture along the center line of a crowned pavement or along the highest side of a sloped cross-section. Place the mixture in consecutive adjacent strips. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread, raked, and luted by hand tools. The longitudinal joint in the RMP shall be offset from the longitudinal joint in the underlying asphalt pavement by at least 1 foot.

#### 3.7.1 Rollers

Use small (2-ton maximum) tandem steel wheel vibratory rollers to smooth over the surface of freshly placed open graded bituminous mixture. Turn off the vibratory unit during smoothing of the bituminous mixture. Keep rollers in good condition, capable of operating at slow speeds to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to roll the mixture to the voids total mix requirement of 25 to 35 percent while it is still in a workable condition. The use of equipment which causes excessive crushing of the aggregate will not be permitted.

#### 3.7.2 Smoothing of Open Graded Bituminous Mixture

The open graded bituminous mixture shall be smoothed with one to three passes of the prescribed roller without vibration. The temperature of the freshly placed open graded bituminous mixture shall be low enough to prevent excessive shoving or cutting of the mat under the roller.

#### 3.7.3 Protection of UngROUTed Pavement

Protect the ungrouted pavement and its appurtenances from traffic and against contamination from mud, dirt, wind blown debris, waterborne material, or any other contamination which could enter the void spaces of the open graded bituminous mixture before grout application. Accomplish protection against contamination by keeping the construction site clean and free of such contaminants and by covering the ungrouted pavement with protective materials when directed by the Contracting Officer. Such protective materials shall consist of rolled polyethylene sheeting as described in paragraph WEATHER LIMITATIONS. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the pavement surface.

### 3.8 PREPARATION OF SLURRY GROUT

Mix the slurry grout using a batch plant, portable mixer and/or ready-mix truck according to mix proportions stated in the approved JMF. Add the cross polymer resin to the mixture after all other ingredients have been thoroughly mixed. When using ready-mix trucks for transporting slurry grout, the grout mixture shall be thoroughly mixed at the job site immediately before application for a minimum of 10 minutes. Thorough mixing shall be accomplished by rotating the mixing drum at the maximum allowable revolutions per minute.

### 3.9 PLACING SLURRY GROUT

Temperature of the bituminous mixture shall be less than 100 degrees F before applying grout. Test each batch of slurry grout at the job site immediately before placement and used in the finished product only if it meets the requirements specified in paragraph ACCEPTABILITY OF WORK. Spread the slurry grout over the bituminous mixture using a spreader or squeegees. The application of the slurry grout shall be sufficient to fill the internal voids of the open graded bituminous mixture. Begin the grouting operation at the lowest side of the sloped cross-section and proceed from the low side to the high side. The practical limit for the surface slope of an RMP section is 2 percent. Pavement slopes up to 5 percent can be constructed, but excess hand work and grout overruns are to be expected at slopes greater than 2 percent. Place the slurry grout in successive paving lanes with a maximum width of 20 feet. The use of strips of wood lumber or foamed rubber to separate each of the grouting lanes and the RMP from adjacent pavements is optional. The direction of the grouting operation shall be the same as used to pave the open graded bituminous mixture. Use the small (2 ton maximum) tandem steel wheel roller (vibratory mode) passing over the grout covered bituminous mixture to promote full penetration of the slurry grout into the void spaces.

### 3.10 JOINTS

#### 3.10.1 Joints Between Successive Lanes of RMP

Make joints between successive lanes of RMP ensuring a continuous bond between the paving lanes. All RMP joints shall have the same texture, density, and smoothness as other sections of the course.

#### 3.10.2 Joints Between RMP and Adjacent Pavements

Saw cut the joints between the RMP and any surrounding pavement surfaced with portland cement concrete to the full thickness of the RMP layer and fill them with a joint sealant material approved by the Contracting Officer.

### 3.11 CURING

Apply the curing compound to the finished pavement surface, by means of a pressurized spraying machine, within 2 hours of the completed slurry grout application. Application of the curing compound shall be made uniformly in one or two coats with a total application rate of not more than 400 square feet/gallon.

### 3.12 PROTECTION OF GROUTED PAVEMENT

Protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents for a period of 21 days. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the Contractor's expense. In order to properly protect the pavement against the effects of rain before the pavement is sufficiently hardened have available, at all times, materials for the protection of the edges and surfaces of the unhardened RMP. The protective materials and method of application shall be the same as previously described in paragraph WEATHER LIMITATIONS. When rain appears imminent, all paving operations shall stop, and all available personnel shall begin covering the surface of the hardened RMP with protective covering.

### 3.13 CONTRACTOR QUALITY CONTROL

#### 3.13.1 General Quality Control Requirements

Develop an approved Quality Control Plan. Hot-mix asphalt for payment shall not be produced until the Quality Control Plan has been approved. The plan shall address all elements which affect the quality of the pavement including, but not limited to:

- a. Mix Design
- b. Aggregate Grading
- c. Quality of Materials
- d. Stockpile Management
- e. Proportioning
- f. Mixing and Transportation
- g. Mixture Volumetrics
- h. Moisture Content of Mixtures
- i. Placing and Finishing
- j. Joints
- k. Compaction
- l. Surface Smoothness

### 3.13.2 Quality Control Testing

Perform all quality control tests, applicable to these specifications, as set forth in the Quality Control Program. The testing program shall include, but shall not be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, slurry grout viscosity, grade and smoothness. Develop a Quality Control Testing Plan as part of the Quality Control Program.

### 3.13.3 Asphalt Content

A minimum of two tests to determine asphalt content will be performed per days production of open-graded asphalt mix, by one of the following methods: the extraction method in accordance with (b) (7)(E) the ignition method in accordance with the (b) (7)(E), or the (b) (7)(E) in accordance with (b) (7)(E), provided the nuclear gauge is calibrated for the specific mix being used. For the extraction method, determine the weight of ash, as described in (b) (7)(E), as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. Use the last weight of ash value obtained in the calculation of the asphalt content for the mixture.

### 3.13.4 Gradation

Aggregate gradations shall be determined a minimum of twice per day from mechanical analysis of recovered aggregate in accordance with (b) (7)(E). When asphalt content is determined by the nuclear method, determine aggregate gradation from hot bin samples on batch plants, or from the cold

feed on drum mix plants. For batch plants, test aggregates in accordance with (b) (7)(E) using actual batch weights to determine the combined aggregate gradation of the mixture.

#### 3.13.5 Temperatures

Check temperatures at least four times per day, at necessary locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

#### 3.13.6 Aggregate Moisture

Determine the moisture content of aggregate used for production a minimum of once per day in accordance with (b) (7)(E) .

#### 3.13.7 Moisture Content of Mixture

Determine the moisture content of the mixture at least once per lot in accordance with (b) (7)(E) or an approved alternate procedure.

#### 3.13.8 Air Voids

Determine voids total mix from random core samples taken from in-place open-graded asphalt mixture. Calculate sample voids as outlined in the Job Mix Formula criteria. Voids shall be between 25 and 35 percent. Material not meeting the void criteria shall be removed and replaced at no additional cost to the Government.

#### 3.13.9 Grade and Smoothness

Conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraph ACCEPTABILITY OF WORK.

##### 3.13.9.1 Grade

The final wearing surface of the pavement will be tested for conformance with specified plan grade requirements, before grout is applied. The grade will be determined by running lines of levels at intervals of 25 feet, or less, longitudinally and transversely, to determine the elevation of the completed pavement surface. Within 5 working days, after the completion of a particular area, the Contracting Officer will inform the Contractor in writing, of the results of the grade-conformance tests.

##### 3.13.9.2 Smoothness

Perform all testing in the presence of the Contracting Officer. Detailed notes of the results of the testing shall be kept and a copy furnished to the Government immediately after each day's testing. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), finish the surface to meet the approval of the Contracting Officer. After the the slurry grout has sufficiently cured, but not later than 48 hours after placement, test the surface of the pavement in such a manner as to reveal all surface irregularities exceeding the tolerances specified in table VI. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines. The transverse lines shall be 25 feet or less apart, as directed. The longitudinal lines shall be at the centerline of each paving lane for lines less than 20 feet and at the third points for lanes 20 feet or greater. Also test other areas having obvious deviations. Longitudinal testing lines shall be continuous across all joints. The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding

(unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points.

#### 3.13.10 Job-Mix-Formula

Routine testing for acceptability of work shall be performed by a Corps of Engineers certified commercial laboratory hired by the Contractor and approved by the Contracting Officer. Additional tests required to determine acceptability of non-conforming material shall be performed by the Contractor at its own expense. Use a Marsh Flow Cone for testing the viscosity of grout.

### 3.14 ACCEPTABILITY OF WORK

#### 3.14.1 General

When a section of pavement fails to meet the specification requirements, that section shall be totally removed and replaced at the Contractor's expense. The Contracting Officer reserves the right to sample and test any area which appears to deviate from the specification requirements.

#### 3.14.2 Field Sampling of RMP Materials

##### 3.14.2.1 Open Graded Bituminous Mixture

Take samples of open graded bituminous mixture from loaded trucks for every 1,000 square yards of pavement, but not less than two samples for each day of paving for determining asphalt content, aggregate gradation, and laboratory compacted voids total mix. Laboratory specimens of open graded bituminous material shall be compacted in 4 inch diameter molds to a 2 inch thickness using 25 blows on one side from a Marshall hand hammer. Compare test results from the sampled open graded bituminous mixture to the approved job-mix-formula for acceptance by the Contracting Officer. The tolerances given in Table IV for sieve analysis, bitumen content, and temperature shall be applied to quality control test results on the open graded bituminous mixture as discharged from the mixing plant.

TABLE IV

#### JOB-MIX-FORMULA TOLERANCES

Material	Tolerance, Plus or Minus
-----	

(b) (7)(E)

##### 3.14.2.2 Slurry Grout

Test each batch of slurry grout for viscosity at the jobsite after thorough mixing and before application. Reject any batch of slurry grout failing to meet the specified viscosity and remove it from the jobsite. Slurry grout with visible amounts of sand settling out of suspension during application shall be rejected and removed from the jobsite.

### 3.14.2.3 Core Samples

Take random core samples from the in-place open graded bituminous mixture before and after application of the slurry grout. Take at least two field core samples before grout application and two after grout application for every 1,000 square yards of finished RMP. Half of the core samples taken after grout application shall be taken from joints between successive grouting lanes. Field core samples shall be 4 or 6 inch diameter and extend the full depth of the RMP surface layer. The ungrouted core samples shall be tested for thickness. The grouted core samples shall be visually inspected for acceptable grout penetration. Acceptable grout penetration shall be through the full thickness of the RMP layer with a minimum of 90 percent of the visible void spaces filled with slurry grout. After testing, turn over all cores to the Contracting Officer. Core holes in ungrouted RMP shall be filled with hot open graded bituminous material and leveled to match the surrounding pavement surface. Core holes in grouted RMP shall be filled within 24 hours from the time of coring with RMP material, low-shrinkage portland cement concrete material, or other approved patching material.

### 3.14.3 Thickness, Grade and Surface-Smoothness Requirements

Finished surface of RMP, when tested as specified below, shall conform to the thickness and grade specified and to surface smoothness requirements specified in Table VI. In areas where the thickness, grade or smoothness exceeds the tolerance, remove the surface lift to full depth; replace the lift with open graded asphalt to meet specification requirements, at no additional cost to the Government. Diamond grinding may be used, after grout has cured, to remove high spots to meet grade or smoothness requirements. Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted.

TABLE VI

SURFACE-SMOOTHNESS TOLERANCES

Direction of Testing	Resin Modified Pavement Tolerance, inch
-----	
Longitudinal	1/4
Transverse	1/4

#### 3.14.3.1 Thickness

The thickness of the RMP shall meet the requirements shown on the contract drawings. The measured thickness of the RMP shall not exceed the design thickness by more than 1/2 inch, or be deficient in thickness by more than 1/4 inch.

#### 3.14.3.2 Surface Smoothness

Finished surfaces shall not deviate from testing edge of a 12 foot straightedge more than the tolerances shown for the respective pavement category in Table VI.

#### 3.14.3.3 Surface Texture

The surface texture shall be uniform and free of excess cement grout. Finished surface shall have all grout removed below the top of the open-graded asphalt concrete.

#### 3.14.3.4 Grade

The finished surface of pavement shall conform to the elevations and the cross sections shown and shall vary not more than 0.6 inch from the plan grade established and approved at site of work. Finished surfaces at juncture with other pavements shall coincide with finished surfaces of abutting pavements.

-- End of Section --

SECTION 32 15 00

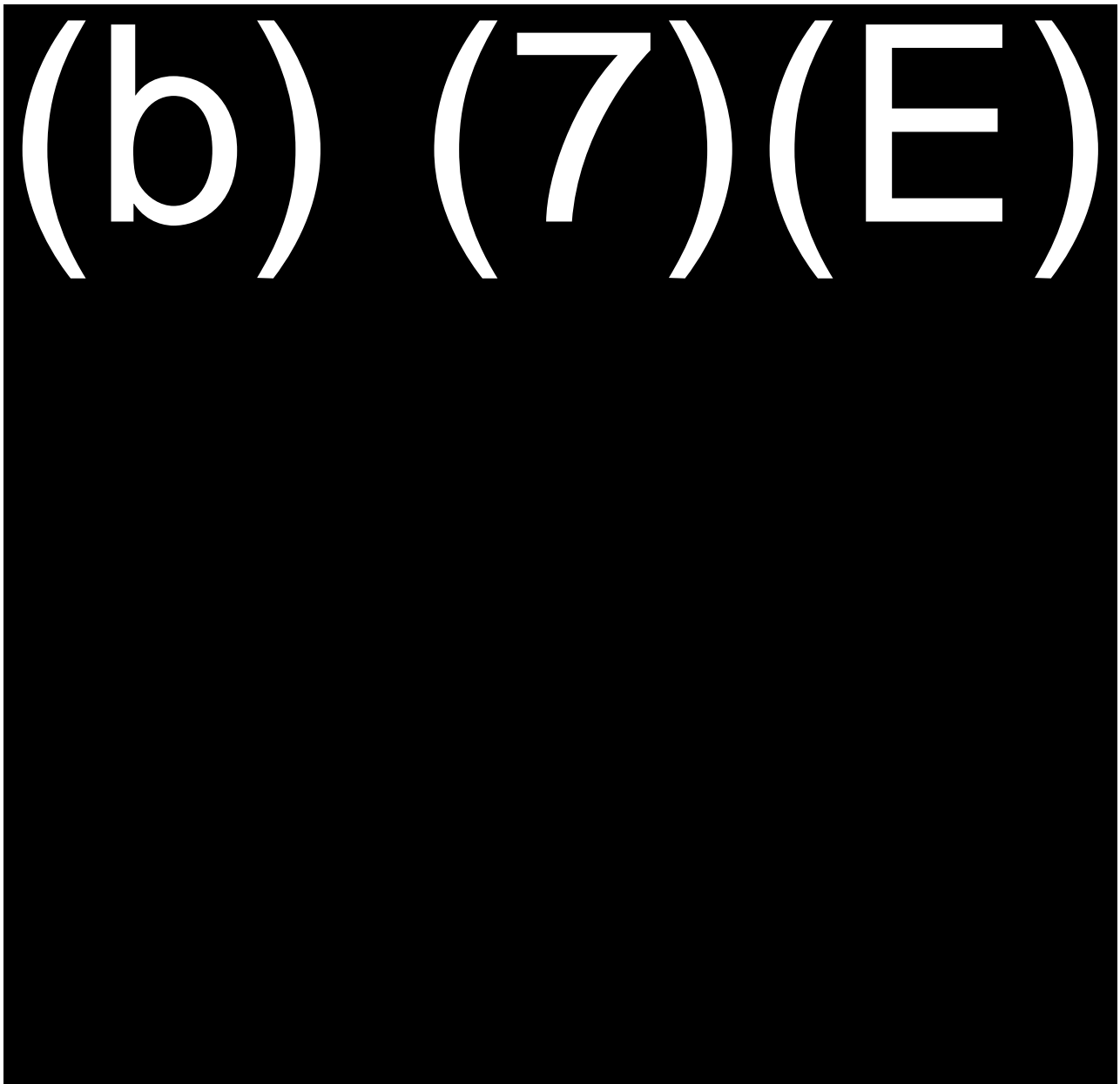
AGGREGATE SURFACE COURSE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)





## 1.2 PAYMENT

Payment for Aggregate Surface Course as described herein and in the project plans will constitute full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the work as lump sum cost.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-03 Product Data

#### Equipment

List of proposed equipment to be used in performance of construction work including descriptive data.

### SD-06 Test Reports

#### Sampling and Testing Density Tests

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Test results from samples, not less than 30 days before material is required for the work. Results of laboratory tests for quality control purposes, for approval, prior to using the material.

### SD-07 Certificates

#### Aggregate Surface Course; G

## 1.4 EQUIPMENT

All plant, equipment, and tools used in the performance of the work covered by this section will be subject to approval by the Contracting Officer before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, and meeting the grade controls, thickness controls, and smoothness requirements set forth herein.

## 1.5 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory or by the Contractor, subject to approval. If the Contractor elects to establish its own testing facilities, approval of such facilities will be based on compliance with **(b) (7)(E)**. No work requiring testing will be permitted until the Contractor's facilities have been inspected and approved.

#### 1.5.1 Sampling

Sampling for material gradation, liquid limit, and plastic limit tests shall be taken in conformance with (b) (7)(E). When deemed necessary, the sampling will be observed by the Contracting Officer.

#### 1.5.2 Testing

##### 1.5.2.1 Gradation

Aggregate gradation shall be made in conformance with (b) (7)(E). Sieves shall conform to (b) (7)(E).

##### 1.5.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with (b) (7)(E).

#### 1.5.3 Approval of Materials

The source of the material to be used for producing aggregates shall be selected 14 calendar days prior to the time the material will be required in the work. Approval of sources not already approved by the Corps of Engineers will be based on an inspection by the Contracting Officer. Tentative approval of materials will be based on appropriate test results on the aggregate source. Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and compacted surface course.

#### 1.5 WEATHER LIMITATIONS

Aggregate surface courses shall not be constructed when the ambient temperatures is below 35 degrees F and on subgrades that are frozen or contain frost. It shall be the responsibility of the Contractor to protect, by approved method or methods, all areas of surfacing that have not been accepted by the Contracting Officer. Surfaces damaged by freeze, rainfall, or other weather conditions shall be brought to a satisfactory condition by the Contractor.

### PART 2 PRODUCTS

#### 2.1 AGGREGATE SURFACE COURSE

The aggregate surface course shall conform to the following gradation and plasticity index provided in the construction plans.

### PART 3 EXECUTION

#### 3.1 OPERATION OF AGGREGATE SOURCES

Clearing, stripping, and excavating shall be the responsibility of the Contractor. The aggregate sources shall be operated to produce the quantity and quality of materials meeting these specification requirements in the specified time limit. Upon completion of the work, the aggregate sources on Government property shall be conditioned to drain readily and be left in a satisfactory condition. Aggregate sources on private lands shall be conditioned in agreement with local laws or authorities.

### 3.2 STOCKPILING MATERIALS

Prior to stockpiling the material, the storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled in such a manner that will prevent segregation. Aggregates and binders obtained from different sources shall be stockpiled separately.

### 3.3 PREPARATION OF UNDERLYING SUBGRADE

See Section 31 00 00, paragraph 3.12 for subgrade requirements

### 3.4 GRADE CONTROL

The Contractor shall grade the aggregate road from existing to new road so to ensure a seamless transition with no abrupt grade changes along both the road profile and super-elevation.

### 3.5 MIXING AND PLACING MATERIALS

The materials shall be mixed and placed to obtain uniformity of the material and a uniform optimum water content for compaction. The Contractor shall make adjustments in mixing, placing procedures, or in equipment to obtain the true grades, to minimize segregation and degradation, to obtain the desired water content, and to ensure a satisfactory surface course.

### 3.6 LAYER THICKNESS

The aggregate material shall be placed on the underlying course in layers of uniform thickness. When a compacted layer of (b) (7)(E) or less is specified, the material may be placed in a single layer; when a compacted thickness of more than (b) (7)(E) is required, no layer shall exceed (b) (7)(E) nor be less than (b) (7)(E).

### 3.7 COMPACTION

Each layer of the aggregate surface course shall be compacted with approved compaction equipment. The aggregate surface course should be compacted at a moisture content not more than 2% above and not more than 3% below the optimum moisture content. In locations not accessible to the rollers, the mixture shall be compacted with mechanical tampers. Compaction shall continue until each layer through the full depth is compacted to at least 95% percent of laboratory maximum density. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked to produce a satisfactory material.

### 3.8 PROOF ROLLING

Proof rolling of the areas designated shall be in addition to compaction specified above and shall consist of application of 30 coverages with a heavy rubber-tired roller, dump truck, water truck or other equipment weighing at least 25-tons. In the areas designated, proof rolling shall be applied to the top lift of layer on which surface course is laid and to each layer of the base course. Water content of the lift of the layer on which the surface course is placed and each layer of the aggregate surface course shall be maintained at optimum or at the percentage directed from the start of compaction to the completion of a proof rolling. Materials in the aggregate surface course or underlying materials indicated unacceptable by the proof rolling shall be removed and replaced, as directed, with acceptable materials.

### 3.9 SMOOTHNESS TEST

The surface of each layer shall not show any deviations in excess of 3/8 inch when tested with a 10 foot straightedge applied both parallel with and at right angles to the centerline of the area to be paved. Deviations exceeding this amount shall be corrected by the Contractor by removing material, replacing with new material, or reworking existing material and compacting, as directed.

### 3.10 THICKNESS CONTROL

The completed thickness of the aggregate surface course shall be within 1/2 inch, plus or minus, of the thickness indicated on plans. The thickness of the aggregate surface course shall be measured at intervals in such manner that there will be a thickness measurement for at least each 500 square yards of the aggregate surface course. The thickness measurement shall be made by test holes at least 3 inches in diameter through the aggregate surface course. When the measured thickness of the aggregate surface course is more than 1/2 inch deficient in thickness, the Contractor, at no additional expense to the Government, shall correct such areas by scarifying, adding mixture of proper gradation, reblading, and recompact, as directed. Where the measured thickness of the aggregate surface course is more than 1/2 inch thicker than that indicated, it shall be considered as conforming with the specified thickness requirements plus 1/2 inch. The average job thickness shall be the average of the job measurements determined as specified above, but shall be within 1/4 inch of the thickness indicated. When the average job thickness fails to meet this criterion, the Contractor shall, at no additional expense to the Government, make corrections by scarifying, adding or removing mixture of proper gradation, and reblading and recompact, as directed.

### 3.11 DENSITY TESTS

Density shall be measured in the field in accordance with (b) (7)(E)

### 3.12 WEAR TEST

Wear tests shall be made in conformance with (b) (7)(E).

### 3.13 MAINTENANCE

The aggregate surface course shall be maintained during construction in a condition that will meet all specification requirements until accepted.

-- End of Section --

SECTION 32 31 00.00 10

FENCING 04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

(b) (7) (E)

(b) (7) (E)

## 1.2 SYSTEM DESCRIPTION

Provide the specified and indicated fencing system including design, materials (structural steel, sheathing, fabric, pickets, rebar, and accessories) installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing in accordance with this section except as modified elsewhere in this contract.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

Submit system layout, elevations, sections, and details including reinforcement and connections. Provide connection, forming and stiffening details for Structural Steel. Avoid ledges, crevices and pockets that hold water, water-laden debris or condensation. Under such circumstances, corrosion will take place in these areas.

### SD-03 Product Data

Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fencing:

Fence welded wire mesh fabric, and sheathing

Accessories

Anchorage, lifting, and connection inserts and accessories.

Note: Fence framing, tubular steel bollards, tubular steel rails, wide flange columns, beams, and rail submittals under Section 05 12 00.

## SD-04 Samples

### Surface Finish

Submit sample items, sizes as directed, representative of color and finish for each exposed component in fencing system.

## SD-07 Certificates

### Fence Fabric – Welded Wire Mesh

Statement, signed by an official authorized to certify on behalf of the manufacturer, attesting that the fabric and component materials meet the specified requirements.

## 1.4 DELIVERY, STORAGE, AND HANDLING

### 1.4.1 Delivery and Storage

Material delivered to site including structural steel shall be inspected for damage, unloaded, and stored with a minimum of handling. Material shall not be stored directly on the ground.

### 1.4.2 Handling

Material shall be handled in a manner that ensures installation in sound, undamaged condition. Material shall be carried to its final location, not dragged.

## PART 2 PRODUCTS

### NOT USED

## PART 3 EXECUTION

### 3.1 COORDINATION

Coordinate this work with associated work including but not limited to Continuous Concrete Retaining Wall (Section 03 30 00.00 40 Cast-In-Place Concrete).

### 3.2 PROTECTION

Care shall be taken while handling structural steel in the field to avoid unsightly gouges and scrapes. The material should be kept as clean as possible away from mud, grease, oil, paint, concrete, mortar splatter and other foreign substances to minimize costly cleaning. Paint or crayon identification marks should be made in locations not visible on the finished structure. Otherwise, these marks must be removed from the visible surfaces during the final cleaning operation.

Storage in transit, yards or at job sites should be minimized. When storage is unavoidable, position the material in an exposed area with good drainage. Blocking, to avoid contact with the ground, is essential. Cover cloths also may prevent water staining and dirt accumulation.

### 3.3 PREPARATION

Verify that the traversed area on either side of the fence line has been cleared and graded to the extent indicated as per applicable sections. Verify the appropriate subgrade or foundation including but not limited to continuous concrete footing is as per applicable sections and drawings.

### 3.4 FENCE SYSTEM – BOLLARD AND PANEL INSTALLATION

The fence system shall be installed as shown to the lines and grades indicated. Bollards and panels shall be set plumb and true to the lines shown on the drawings. Bollard shall be cleared of loose material. Waste material shall be spread where directed. Structural steel erection shall conform to Section 05 12 00. Bollards shall be set in concrete in soil to the depth indicated and as shown on the drawings. Concrete shall be thoroughly consolidated around each bollard and shall be free of voids. Finish the sloped or rounded surface to prevent ponding water around the base of bollards and fence. Concrete shall be allowed to cure for 72 hours prior to attachment of any item to the bollards assemblies.

HSS bollards shall be installed in slat fashion as shown. HSS bollards shall be reinforced as shown. TS bollards shall either be embedded as shown and then filled solid full or partial height as shown on drawings with the indicated material. Cap bollards as shown.

### 3.5 WELDED WIRE MESH FABRIC

Fabric shall be installed on the side of the HSS bollard indicated. Fabric shall be attached to HSS bollards with connection angles, spaced no farther apart than intervals specified on the plans. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric or reducing the fabric height. Fabric shall be cut as per manufacturers' instructions. Splicing shall be accomplished in accordance with manufacturers' instructions. The bottom of the installed fabric shall be mounted flush with the top of the wall. After the fabric installation is complete, the fabric shall be exercised by applying a (b) (7)(E)

all failed panels shall be resecured and retested at the Contractor's expense.

### 3.6 WELDING

Field welding shall conform to Sections 05 05 23 Welding, Structural and 05 12 00 Structural Steel.

### 3.7 GROUNDING

Fences shall be grounded on each side of all gates, at each corner, at the closest approach to each building (b) (7)(E)

(b) (7)(E)

-- End of Section --



## SECTION 32 92 19

### SEEDING

#### 1.0 Description:

The work under this item shall consist of furnishing all materials, preparing the soil, applying seed, and establishing the seeded areas.

Areas to be seeded are those disturbed or unvegetated areas listed herein, shown on the plans, called for in the contractor's erosion control plan, or designated by the Contracting Officer's Representative (COR).

Seeding shall be accomplished in two stages. The first stage shall consist of tillage, furnishing and applying chemical fertilizer, furnishing and planting the contract-specified seed mix, and furnishing, applying and affixing mulch. The second stage, beginning after the first stage has been accepted by the COR, shall be a 45 calendar-day period during which time the contractor shall be responsible for maintaining and stabilizing the seeded and mulched areas, and restoring damaged or eroded areas.

#### 2.0 Materials:

##### 2.01 General:

Appropriate documentation, as specified below, shall be submitted to the COR a minimum of 30 calendar days before the start of a scheduled seeding activity. No materials shall be delivered to the site until the documentation has been approved by the COR.

Unless otherwise specified, the contractor shall perform all testing, or provide test results to the Engineer from accredited laboratories as specified herein.

##### 2.02 Seed:

###### (A) General Requirements:

The species, variety, and strain of seed (designated elsewhere herein as contract-specified seed) shall be as specified herein. The contract-specified seed shall be obtained from seed suppliers through harvesting of wildland collections, or field-grown seeds grown prior to or during the contract period.

Within 30 calendar days after the award of contract, the contractor shall submit the name of the seeding subcontractor to be used, along with written confirmation from seed suppliers and collectors, on their letterhead, that the source(s) for the contract-specified seed has been secured. If any of the contract-specified seed is expected to not be available during the contract period prior to seeding, in accordance with Subsection 2.02(B) below, the contractor shall notify the COR at this same time.

The seed shall be delivered to the project site unmixed in standard, sealed, undamaged containers for each seed species. Each container shall be labeled in accordance with the appropriate provisions of the U.S. Department of Agriculture rules and regulations under the Federal Seed Act. Labels shall indicate the variety or strain of seed, the percentage of germination, purity and weed content, the date of analysis which shall not be more than nine months prior to the delivery date, and testing information. A Certificate of Analysis from an accredited seed-testing laboratory shall accompany each container of seed.

Unless otherwise approved by the COR, weed content of the contract-specified seed mix shall not exceed 0.5 percent.

The contractor shall provide all seed tag labels to the COR. No payment will be made for seed unless tag labels from all seed to be used on the project have been submitted as specified.

The contractor shall store seed under dry conditions, at temperatures of between 35 °F and 120 °F, and out of direct sunlight. Prior to using the seed, the contractor shall provide a certification letter to the COR that the seed was stored as specified herein.

Legume seed shall be inoculated with appropriate bacteria cultures approved by the COR, in accordance with the culture manufacturer's instructions.

Tetrazolium staining shall be acceptable to test for germination and hard seed. Cut or fill testing will not be allowed. As directed by the COR, seeds with an expiration date past the acceptable test date or not meeting the specified conditions for storage shall be retested by the contractor. The COR may perform random sampling of seeds throughout the project. Mixing of the specified seed at the project site shall be under the supervision of the COR.

Application rates of seed as specified are for Pure Live Seed (PLS). PLS is determined by multiplying the sum of the percent germination of seeds, including hard or dormant seeds, by the percent purity.

Seed mix species and the Pure Live Seed (PLS) rates are shown in Table 1 below:

TABLE 1	
SEED MIX	
Variety	Pounds Per Acre
Green Sprangletop	0.3
Sideoates Grama	3.6
Plains Bristlegrass	1.2
Buffalo Grass	1.6
Bluestem	1.3
Seed added to assist for rapid growth	
Millet	20
Oats	20

(B) Seed Substitution:

No substitution of the contract-specified seed will be allowed unless evidence is submitted documenting that the contractor has made a diligent effort to obtain the contract-specified seed, from either seed suppliers or collectors, and that the contract-specified seed will not become available prior to the time specified for seeding in the contractor's approved construction schedule.

Should a substitution of the contract-specified seed be requested, and the contractor's documentation is approved by the COR, the contractor shall submit an alternate seed within five working days for approval by the COR. The alternate seed will only be allowed when there is an insufficient quantity of the contract-specified seed for the areas to be seeded as called for herein or as required for erosion control. The contractor shall obtain and apply the alternate seed, as required, to all such remaining areas. Unless otherwise approved by the COR, the approved alternate seed will only be allowed until such time that contract-specified seed meeting the availability and price requirements specified herein can be provided.

No additional payment will be made for areas requiring re-seeding following the application of unapproved seed.

2.03

Tacking Agent:

Tacking agent shall be a naturally occurring organic compound and be non toxic. It shall be a product typically used for binding soil and mulch in seeding or erosion control operations. Approved types shall consist of mucilage or gum by dry weight as active ingredient obtained from guar or plantago. The tacking agent shall be labeled indicating the type and mucilage purity.

The contractor shall have the tacking agent swell volume tested by an approved testing laboratory using the USP method. The standard swell volume shall be considered at 30 milliliters per gram. Material shall have a swell volume of at least 24 milliliters per gram. Certified laboratory test results shall be furnished to the COR for each shipment of homogenous consistency to be used on project areas or as directed by the COR. Tacking agent rates shall be adjusted to compensate for swell volume variation. Material tested with lesser volume shall have the tacking agent rate increased by the same percentage of decrease in swell volume from the standard 30 milliliters per gram. Material tested with greater volume may reduce tacking agent rates by the same percentage of increase in swell volume from the standard 30 milliliters per gram. Tacking agent shall be pure material without other starches, bentonite, or other compounds that would alter the swell volume test results of mucilage, or the effectiveness of the tacking.

2.04

Wood Fiber Mulch:

Wood cellulose fiber mulch shall be from thermo-mechanically processed wood, processed to contain no growth germination inhibiting factors. The mulch shall be from virgin wood manufactured and processed so the fibers will remain in uniform suspension in water under agitation to form homogenous slurry. Wood fiber mulch shall have no toxic effect when combined with seed or other materials. A colored dye which is noninjurious to plant growth may be used. The wood fiber mulch shall be delivered in undamaged, labeled containers bearing the name of the manufacturer and showing the air-dry water content. Paper products will not be considered as virgin wood. The wood fiber mulch shall have the properties shown in Table 2 below:

TABLE 2	
Virgin Wood Cellulose Fiber	90% min.
Recycled Cellulose Fiber	10% max.
Ash Content	0.8% +/-0.3%
PH	4.5 +/-1.0
Water Holding Capacity	10:1 (water:fiber)

2.05

Straw Mulch:

Straw mulch shall be from oats, wheat, rye or other grain crops, and shall be from the current season's crop and shall be in an air-dry condition suitable for placing with mulch blower equipment. A letter of certification from the supplier shall be required stating that the straw was baled less than 12 months from the delivery date.

All straw shall be free from noxious weeds, mold or other objectionable material in compliance with the standards and procedures of the North American Weed Management Association (NAWMA). The contractor shall provide documentation, including a transit certificate, and appropriate labels and/or marking twine. The straw shall be accompanied by the certification, labels and/or marking twine at the time of delivery to the project site. Straw delivered to the project without such information will be rejected, and promptly removed from the project.

2.06 Water:

Water shall be free of oil, acid, salts or other substances which are harmful to plants. The source shall be as approved by the COR prior to use.

3.0 Construction Requirements:

3.01 General:

The contractor shall notify the COR at least two days prior to commencing seeding operations.

The equipment and methods used to distribute seeding materials shall provide an even and uniform application of seed, mulch, and other materials at the specified rates.

Seeding operations shall not be performed on undisturbed soil outside the clearing and grubbing limits of the project.

The contractor shall coordinate the seeding operations with the grading operations to determine mobilization frequency as embankment and cut slopes are finished throughout the duration of the project. Seeding shall be done during suitable weather and soil conditions for tillage and placement of materials. Seeding operations shall not be performed when wind would prevent uniform application of materials or would carry seeding materials into areas not designated to be seeded.

Frequent mobilizations may be required to accomplish seeding as specified herein. No adjustments will be made to the contract for the number of seeding mobilization activities. Should the contractor fail to provide seeding for a sub-area as specified herein, the COR will immediately notify the contractor of such non-compliance. Should the contractor fail to immediately remedy the unstabilized area, the COR may suspend work until such seeding stabilization has been completed, or proceed to provide the necessary seeding stabilization. No adjustment to the contract time will be made for suspensions resulting from the contractor's failure to provide seeding for a sub-area within the contract time periods.

Seeding shall also be applied to finished grades at all areas disturbed by construction activities within the project permanent and temporary easements, except within the levee and access roads. Seeding and mulching shall be done in two separate steps. For the first step, seed shall be applied by hydroseeding for both types of shoulder build-up areas.

Where erosion control mats are called for in the construction plans, the erosion control mats shall be placed over the seeding and anchored as required. Mulch shall be omitted where erosion control mats are called for in the construction plans.

3.02 Seeding:

(A) General:

Hydroseeding shall be the method for seed distribution for this project.

Straw mulch or wood fiber mulch shall be applied on hydroseeded areas, as specified herein or directed by the COR, within 24 hours of seed application.

Ground coverage at completion of seeding activities shall be no less than 80% as determined and accepted by the COR.

(B) Hydroseed Method:

Seed mix shall be hydroseeded with straw mulch or wood fiber mulch applied following application of the seed. The contract-specified seed shall be applied in a slurry containing a minimum of 40 pounds tacking agent and 200 pounds of wood fiber mulch per acre. Seed shall not be in the slurry for more than 30 minutes. Seed planted by this method will not require covering with soil. Soil areas shall be tilled to produce loose and friable surfaces with crusted hard soils broken up prior to hydroseeding.

3.04 Applying Straw Mulch:

(A) General:

Within 24 hours after each area is hydroseeded, straw mulch shall be uniformly applied at the minimum rate of 2 tons per acre.

During seeding and mulching operations, care shall be exercised to prevent drift and displacement of materials. Mulch material which is placed upon trees and shrubs, roadways, structures and upon any areas where mulching is not specified or which is placed in excessive depths on mulching areas shall be removed as directed. Mulch materials which are deposited in a matted condition shall be loosened and uniformly spread, to the specified depth, over the mulching areas. Any unevenness in materials shall be immediately corrected by the contractor.

Except as specified in the next paragraph, straw mulch applied to drill seeded or hydroseeded areas shall be immediately affixed by crimping and tacking after application. No mulch shall be applied to seeding areas which can not be crimped and/or tacked by the end of each day. Any drifting or displacement of mulch before crimping and/or tacking shall be corrected by the contractor at no additional cost to the Government.

Crimping shall not be required for areas that are steeper than 3:1. Crimping may also be waived, when specifically directed by the COR, for drill seeded or hydroseeded areas with rocky conditions or other areas deemed unsuitable by the COR for crimping. Straw mulch applied to such drill seeded or hydroseeded areas shall only be tacked, as specified in Subsection 3.04(C) below.

Prior to the application of a tacking agent, protective covering shall be placed on all structures and objects where stains would be objectionable. All necessary precautions shall be taken to protect the traveling public and vehicles from damage due to drifting spray.

(B) Anchorage by Tacking:

Straw mulch shall be anchored by tacking using a slurry consisting of a minimum of 150 pounds of tacking agent, 500 pounds of wood fiber mulch, and 300 gallons of water per acre. The contractor may increase the quantities of components to ensure the stability of the straw mulch to provide erosion control during the 45 calendar-day maintenance period at no additional cost to the Department.

3.05 Applying Wood Fiber Mulch with Tacking Agent:

Areas seeded but not practical for straw mulch, as determined by the COR, shall have wood fiber mulch with tacking agent applied at the variable rates shown in the Table 4 below.

TABLE 4		
Slope (H:V)	Tacking agent (Pounds pure	Wood Fiber Mulch

	mucilage per acre)	(Pounds per acre)
Flat to 4:1	50	1,000
From greater than 4:1 to 3:1	100	2,000
From greater than 3:1 to 2:1	150	2,500
Greater than 2:1	200	3,000
Erosive Soil Slopes*	300	3,500
*As determined by Engineer		

The contractor shall submit a batch (tank) mix quantity schedule for seed application and the temporary erosion control mulch application for approval of the COR prior to mixing seed, fertilizer, wood fiber mulch and tacking agent in a slurry. Batch mixing and coverage will be monitored throughout the seeding operations. The contractor shall coordinate the mixing and application operations with the Engineer in advance of all mixing.

### 3.06 Seeding Acceptance:

Seeding application shall meet 80% coverage, minimum and after application the COR will inspect seeded areas or sub-areas for conformance. The contractor shall correct, to the satisfaction of the COR, any areas not conforming to the specifications. The 45-day maintenance period will begin upon acceptance of the area by the COR.

The contractor shall maintain and stabilize each area or sub-area for a minimum period of 45 calendar days after application of the seeding and mulching materials, and acceptance by the COR. Any areas damaged from erosion, or that have less than 90 percent of applied mulch remaining, shall be re-seeded, re-mulched, and re-tacked at no additional cost to the Government.

## CELLULAR CONFINEMENT REINFORCEMENT

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Geosynthetic to provide reinforcement for mechanically stabilized earth retaining structures (walls, slopes and embankments).
- B. Reinforced Backfill.

#### 1.2 RELATED SECTIONS

- A. Document 00300 - Information Available to Bidders: Geotechnical Report; Bore hole locations and findings of subsurface materials.
- B. Section 01400 - Testing and Inspection Services.
- C. Section 02200 - Site Preparation.
- D. Section 02300 - Earthwork; Excavation and subgrade preparation.
- E. Section 02310 - Grading.
- F. Section 02315 - Excavation.
- G. Section 02316 - Fill and Backfill.
- H. Section 02920 - Lawns and Grasses; Ground cover at finished grade.

#### 1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO)

1. (b) (7)(E)

- B. ASTM, International

1.  
2.  
3.  
4.  
5.  
6.  
7.  
8.  
9.  
10.  
11.

(b) (7)(E)

12. (b) (7)(E)  
13.  
14.  
15.

C. Geosynthetic Research Institute (GRI)

1. (b) (7)(E)  
2.  
3.

D. National Concrete Masonry Association (NCMA)

1. (b) (7)(E)  
2.  
3.

E. National Highway Institute (NHI) / Federal Highway Administration

1. (b) (7)(E)

1.4 Design Requirements

- A. Design Requirements: Design reinforced soil structure in conformance with the design guidelines of (b) (7)(E) or National Concrete Masonry Association. Design shall be prepared by a professional engineer registered in the state in which the project is located.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Manufacturer's certification that quality management system is ISO 9001 registered.
- C. Manufacturer's certification that the reinforced soil system components meet the requirements of this specification and the structure design.
- D. Mill certification from the polyester fiber manufacturer certifying the molecular weight and carboxyl end group count as specified herein.
- E. A set of detailed design plans sealed by a registered professional engineer licensed in the state of the project. The plans shall include plan and elevation views of each structure, cross sections and all details, dimensions and quantities necessary to construct the structure.
- F. Samples: Two samples of each component including:
1. Cellular confinement: Nominal 6 inch by 10 inch (150 mm by 250 mm) of each type required.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: System components manufactured by licensees or by companies approved and authorized by the component supplier.
- B. Installer Qualifications: Firm with documented experience of at least five projects of similar construction and scope. Include brief description of each project and name and phone number of owner's representative knowledgeable in each listed project.



- C. Reinforced Soil System Engineer: Firm with documented experience of at least five projects of similar construction and scope. Include brief description of each project and name and phone number of owner's representative knowledgeable in each listed project.
- D. Owner shall provide soil testing and quality assurance inspection during earthwork and slope construction operations. Installer shall provide any quality control testing or inspection not provided by the Owner. Owner's quality assurance program does not relieve the installer of responsibility for quality control and structure performance.
- E. Pre-Construction Meeting: Prior to construction of reinforced soil structures, conduct a meeting at the site with the material suppliers, reinforced soil structure installer, and the Contractor to review the reinforced soil structure requirements. Notify the Owner and the Architect at least 3 days in advance of the time of the meeting.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Prevent excessive mud, fluid concrete, epoxy, or other deleterious materials from coming in contact with system components.
- C. Polymeric Materials: During storage, geosynthetic rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, excess temperatures, and any other environmental conditions that may damage the physical property values of the geosynthetic.
- D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

#### 1.8 PROJECT CONDITIONS

- A. Do not place or compact fill material during wet or freezing weather that prevents achievement of specified compaction requirements.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

As part of the manufacturer material approval process, the following requirements for material submittals are requested:

- A. Product data sheets and supporting test results from a certified Independent testing laboratory documenting conformance with this specification.
- B. All certifications as required in Section 1.5 of this specification including fiber mill certification.

#### 2.2 MATERIALS

- A. System Description: Reinforced soil structure consists of a mechanically stabilized engineered backfill reinforced with polyester soil reinforcement products.
- B. Intermediate or Face Wrap Cellular confinement: Approved manufacturer shall provide the following minimum tensile properties:

1. Tensile Requirements:

Property	Method	MicroGrid <sup>1</sup> lb/ft (kN/m)	SG150 lb/ft (kN/m)	SG200 lb/ft (kN/m)	SG350 lb/ft (kN/m)	SG500 lb/ft (kN/m)	SG550 lb/ft (kN/m)	SG600 lb/ft (kN/m)	SG700 lb/ft (kN/m)
T <sub>ult</sub> , Ultimate Tensile Strength	(b) (7)(E)	(b) (7)(E)							
T <sub>a</sub> , Allowable Design Strength									
Soil: SW, SP, SM, SC									
(b) (7)(E)									
Soil: GW, GP, GM, GC, SW, SP, SM, SC									
(b) (7)(E)									
Soil: GW, GP, GM, GC									
(b) (7)(E)									

<sup>1</sup> MicroGrid Ultimate Tensile Strength determined in accordance with (b) (7)(E)

- a. Allowable Tensile Strength (T<sub>a</sub>) shall be defined as T<sub>ult</sub> / RF. Where RF = RFCR x RFD x RFID. Reduction Factor for Creep (RFCR), Reduction Factor for Durability (RFD), and Reduction Factor for Installation Damage (RFID).
  - b. Ultimate Tensile Strength (T<sub>ult</sub>) shall be the minimum average roll value (MARV) as tested per (b) (7)(E)
  - c. Reduction Factor for Creep (RFCR) shall be based on (b) (7)(E) design life determined in accordance with (b) (7)(E). Reduction Factor for Creep (RFCR) shall not be less than (b) (7)(E)
  - d. Reduction Factor for Installation Damage (RFID) shall be based on reinforced backfill type designated above or reinforced backfill gradation as indicated in the approved shop drawings or specifications. Installation damage testing and material sampling shall be in conformance with (b) (7)(E). Reduction Factor for Installation Damage (RFID) shall not be (b) (7)(E)
  - e. Reduction Factor for Durability (RFD) shall be based on (b) (7)(E)  
(b) (7)(E). Reduction Factor for Durability (RFD) shall not be (b) (7)(E)
2. Soil Interaction Coefficient (C<sub>i</sub>) value shall be determined from short-term effective stress pullout tests per (b) (7)(E) over the range of normal stresses encountered. The minimum C<sub>i</sub> value shall not be (b) (7)(E) determined as follows:

(b) (7)(E)

- a.  $F$  = Pullout force per (b) (7)(E)
- b.  $L$  = Geosynthetic embedment length during test, ft (m).
- c.  $sN$  = Effective normal stress, psf (kPa).
- d.  $f$  = Effective soil friction angle, degrees.

- C. Reinforced Backfill: Granular fill with a (b) (7)(E) and graded as follows:

- 1. (b) (7)(E)
- 2. (b) (7)(E)
- 3. (b) (7)(E)
- 4. (b) (7)(E)
- 5. (b) (7)(E)
- 6. (b) (7)(E)
- 7. (b) (7)(E)

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Do not begin installation until excavation, foundation preparation and leveling pad have been completed, properly prepared, and inspected per project specifications.
- B. If subgrade preparation is the responsibility of another installer, notify Architect / Owner's Geotechnical Engineer of unsatisfactory preparation. Do not begin work until unsatisfactory conditions have been rectified as directed by the Owner's Geotechnical Engineer.
- C. Excavation:
  - 1. Excavate the subgrade vertically to the plan elevation and horizontally to the extent of the cellular confinement lengths.
  - 2. Remove soils not meeting required strength and replace with approved materials by the Owner's Geotechnical Engineer.
  - 3. Protect excavated materials to be used for backfilling the reinforcement zone from the weather.
- D. Foundation Preparation:
  - 1. Over-excavated areas of the subgrade shall be filled in maximum loose lifts of (b) (7)(E) in accordance with (b) (7)(E)
  - 2. Owner's Geotechnical Engineer will inspect the subgrade soil for the reinforced zone to ensure proper bearing strength in accordance with the specified Field Quality Control provisions.

#### 3.2 CONSTRUCTION

- A. Construct reinforced soil structure in accordance with the approved shop drawings and Construction and Quality Control Manual supplied by the manufacturer.
- B. Cellular confinement placement:
  - 1. Unroll the cellular confinement and cut to the length indicated in the approved shop drawings.
  - 2. Place cellular confinement on level and compacted reinforced fill at locations indicated in the approved shop drawings.
  - 3. Primary strength direction of the cellular confinement shall be placed perpendicular to the face of the structure or aligned as indicated in the approved shop drawings.

4. Pull the cellular confinement taut to remove slack in the cellular confinement.
5. Stake or pin the cellular confinement near the end to maintain alignment and to prevent development of slack during backfill placement.
6. Adjacent embedment lengths of cellular confinement shall abut to provide (b) (7)(E) coverage at elevations requiring cellular confinement reinforcement, as indicated in the approved shop drawings.
7. Place (b) (7)(E) fill between overlapping layers of cellular confinement where overlapping occurs behind curves and corners.
8. Construction vehicles shall not be operated directly on the cellular confinement. (b) (7)(E) f fill cover over the cellular confinement is required for operation of construction vehicles in the reinforced zone.
9. Turning of vehicles should be avoided to prevent dislocation or damage to the cellular confinement.
10. Primary cellular confinement may not be overlapped or connected mechanically to form splices in the primary strength direction.

C. Reinforced backfill:

1. Place the reinforced backfill material in maximum compacted lifts of (b) (7)(E) and compact to a minimum Standard Proctor Dry Density of (b) (7)(E) of optimum moisture content, per (b) (7)(E) Compaction shall be achieved throughout the full lift thickness. Minimum compaction shall meet or
2. exceed the requirements stated or as required by the project specifications, whichever is more stringent.
3. Use only walk-behind compaction equipment within 3 feet (1 meter) of the structure facing. Use a minimum of 3 passes to compact this zone.
4. Required level of compaction shall be achieved throughout the entire reinforced backfill zone, as measured from the back of the facing unit to the end of cellular confinement reinforcement. Reinforced fill zone limits shall be as indicated on the approved shop drawings.
5. Smooth and level the backfill as indicated so that the cellular confinement lays flat. Grade shall not slope towards the front face of the structure.
6. Separate reinforced fill from the adjacent soil with geotextile, as indicated in the approved shop drawings

### 3.3 FIELD QUALITY CONTROL

- A. Quality Assurance: Testing and Inspection will be provided by the Owners Testing Agency as specified in (b) (7)(E) Notify the Architect /Owner's Geotechnical Engineer 72 hours in advance of testing.
- B. Quality Control: Testing and Inspection shall be provided by an independent laboratory provided by the Contractor and acceptable to the Architect / Owner's Geotechnical Engineer.
- C. Perform laboratory material tests in accordance with (b) (7)(E) .
- D. Perform in place compaction tests in accordance with the following:
  1. Density Tests: (b) (7)(E) as appropriate for material tested.
  2. Moisture Tests: (b) (7)(E)
- A. Minimum Frequency of Tests, or as stated in the contract documents:
  1. Leveling Pad Trench: A minimum rate of one test per 100 feet (30 m) of trench.
  2. Subgrade Soil: A minimum rate of one test per 50 feet (15 m) length of structure.
  3. Reinforced Backfill:

- a. Conduct gradation and plasticity index test at a minimum rate of one test per 2000 cubic yards (1500 cubic meters) and whenever the appearance and behavior of the backfill changes noticeably.
- b. Compaction control testing of the reinforced backfill should be performed on a regular basis during the entire construction project. Conduct compaction control test (Density and Moisture) at a minimum rate of one test within the reinforced backfill zone per every 5 ft (1.5 m) of vertical height for every 100 ft (30 m) of length, approximately every 500 square feet (45 square meters) of vertical face area.

END OF SECTION

(b) (5)

(b) (5)

(b) (5)



(b) (5)

(b) (5)

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#####

**ARTICULATED CONCRETE MAT  
HAND PLACE SPECIFICATION FOR EROSION CONTROL**

**PART 1: GENERAL**

**A. Scope of Work**

The contractor shall furnish all labor, materials, equipment, and incidentals required and perform all operations in connection with the installation of cellular concrete erosion control blocks in accordance with the lines, grades, design and dimensions shown on the Contract Drawings and as specified herein.

**B. Submittal**

The Contractor shall submit to the Engineer all manufacturers' hydraulic testing and calculations in support of the proposed cellular concrete block system and geotextile. The Contractor shall furnish the manufacturer's certificates of compliance for cellular concrete blocks/mats. The Contractor shall also furnish the manufacturer's specifications, literature and any recommendations, if applicable, that are specifically related to the project.

Material must be pre-approved in writing by the Engineer prior to bid date. Material packages must be submitted to the Engineer a minimum of fifteen (15) days prior to bid date. Submittal packages must include, as a minimum, the following:

1. Full-scale laboratory testing submitted by the manufacturer and associated engineered calculations quantifying the hydraulic capacity of the proposed cellular concrete block system in similar conditions to the specific project.
2. A list of 5 comparable projects, in terms of size and applications, in the United States, where the results of the specific alternate revetment system use can be verified after a minimum of one (1) year of service life.

**PART 2: PRODUCT**

**A. General**

All interlocking precast concrete blocks are (b) (7)(E) and shall be manufactured as individual units which shall be packaged in a manner suitable for transportation to the jobsite. The blocks shall be shaped in such a way that (b) (7)(E)

The Contractor shall place the interlocking blocks to the lines and grades shown on the Contract Drawings.

**B. Cellular Concrete Blocks**

**1. Scope**

- 1.1 This specification covers erosion control interlocking blocks used in revetments for soil stabilization.

**Note 1** - Concrete units covered by this specification are made from lightweight or normal weight aggregates, or both.

**Note 2** - The values stated in U.S. customary units are to be regarded as the standard.

**2. Materials**

- 2.1 Cementitious Materials - Materials shall conform to the following applicable ASTM specifications:
  - 2.1.1 Portland Cements - Specification (b) (7)(E) for Portland Cement.
  - 2.1.2 Blended Cements - Specification (b) (7)(E) for Blended Hydraulic Cements.
  - 2.1.3 Hydrated Lime Types - Specification (b) (7)(E) for Hydrated Lime Types.
  - 2.1.4 Pozzolans - Specification (b) (7)(E) for Fly Ash and Raw or Calcined Natural Pozzolans for use in Portland Cement Concrete.
- 2.2 Aggregates shall conform to the following ASTM specifications, except that grading requirements shall not necessarily apply:
  - 2.2.1 (b) (7)(E).

**3. Casting**

- 3.1 The concrete units shall be produced by a dry cast method. The dry cast units obtain strength in a shorter duration as well as an increase in the durability and overall quality of product.

**4. Physical Requirements**

- 4.1 At the time of delivery to the work site, the units shall conform to the physical requirements prescribed in Table 1 below.

TABLE 1. PHYSICAL REQUIREMENTS			
Compressive Strength Net Area Min. psi (MPa)		Water Absorption Max., LB/FT <sup>3</sup> (Kg/M <sup>3</sup> )	
Avg. of 3 units	Individual Unit	Avg. of 3 units	Individual Unit
(b) (7)(E)			

- 4.2 When applicable, the manufacturer shall meet all requirements pertaining to a concrete unit's durability pertaining to a freeze-thaw environment.
- 4.3 Units shall be sampled and tested in accordance with (b) (7)(E) Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems.

## **5. Visual Inspection**

- 5.1 All units shall be sound and free of defects that would interfere with either the proper placement of the unit or impair the performance of the system. Surface cracks incidental to the usual methods of manufacture, or surface chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.
- 5.2 Cracks exceeding 0.25 inches (.635 cm) in width and/or 1.0 inch (2.54 cm) in depth shall be deemed grounds for rejection.
- 5.3 Chipping resulting in a weight loss exceeding 10% of the average weight of a concrete unit shall be deemed grounds for rejection.
- 5.4 Blocks rejected prior to delivery from the point of manufacture shall be replaced at the manufacturer's expense. Blocks rejected at the job site shall be repaired with structural grout or replaced at the expense of the contractor.

## **6. Sampling and Testing**

- 6.1 The purchaser or their authorized representative shall be accorded proper access to facilities to inspect and sample the units at the place of manufacture from lots ready for delivery.
- 6.2 Field installation procedures shall comply with the procedures utilized during the hydraulic testing procedures of the recommended system. All system restraints and ancillary components (such as synthetic drainage mediums) shall be employed as they were during testing. For example, if the hydraulic testing installations utilize a drainage layer then the field installation must utilize a drainage layer; an installation without the drainage layer would not be permitted.
- 6.3 The theoretical force-balance equation used for performance extrapolation tends for conservative performance values of thicker concrete units based on actual hydraulic testing of thinner units. When establishing performance values of thinner units based on actual hydraulic testing of thicker units, there is a tendency to overestimate the hydraulic performance values of the thinner units. Therefore, all performance extrapolation must be based on actual hydraulic testing of a thinner unit then relating the values to the thicker units in the same "family" of blocks.
- 6.4 Additional testing, other than that provided by the manufacturer, shall be borne by the purchaser.

## **7. Manufacturer**

As part of the manufacturer material approval process, the manufacturer needs to comply with all sections in this specification.

## **C. Filter Fabric**

The geotextile filter shall meet the minimum physical requirements listed in Table No. 2 of these Specifications. Consultation with the manufacturer is recommended.

The geotextile must be permitted to function properly by allowing relief of hydrostatic pressure; therefore concrete shall not be allowed to clog the filter fabric.

The geotextile fiber shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic, if necessary, to make the filaments resistant to deterioration due to ultraviolet and heat exposure. The edges of the geotextiles shall be finished to prevent the outer fiber from pulling away from the geotextiles.

The Contractor shall furnish the Engineer, in duplicate, manufacturer's certified test results showing actual test values obtained when the physical properties are tested for compliance with the specifications.

During all periods of shipment and storage, the filter fabric shall be protected from direct sunlight, ultraviolet rays and temperatures greater than 140 degrees Fahrenheit. To the extent possible, the fabric shall be maintained wrapped in its protective covering. The geotextile shall not be exposed to sunlight, ultraviolet rays until the installation process begins.

TABLE 2. PHYSICAL REQUIREMENTS		
Physical Property	Test Procedure	Minimum Value
Grab Tensile Strength (Unaged Geotextile)	(b) (7)(E)	(b) (7)(E)
Breaking Elongation (Unaged Geotextile)		
Burst Strength		
Puncture Strength		
A.O.S., U.S. Std. Sieve		
% Open Area		
Permittivity		

Final acceptance of the filtration geotextile by the Engineer shall be dependent upon the geotextile performance when tested in accordance with (b) (7)(E), Standard Test Method for Measuring the Soil-Geotextile System Clogging by the Gradient Ratio test or the Hydraulic Conductivity Ratio test. Soil characteristics such as grain size analysis, and plasticity shall be determined for every 200,000 square feet of geotextile installed, or for each source of borrow material used during construction. Significant differences in soil characteristics shall require further performance testing by either the Gradient Ratio or the Hydraulic Conductivity Ratio tests at the discretion of the Engineer. The locations for which the material to be tested is extracted shall be approved by the Engineer. The Contractor shall provide the site-specific soil and modified proctor curves for the site-soil, at his own expense, to the manufacturer. The manufacturer shall be responsible for the performance of the test by a certified independent laboratory experienced in performing such test. The test shall be performed under the actual field soil conditions or as otherwise required by the Engineer.

At the time of installation, the filter fabric shall be rejected if it has been removed from its protective cover for over 72 hours or has defects, tears, punctures, flow deterioration, or damage incurred during manufacture, transportation or storage. With the acceptance of the Engineer, placing a filter fabric patch over the damaged area prior to placing the mats shall repair a torn or punctured section of fabric. The patch shall be large enough to overlap a minimum of three (3) feet in all directions.

In the event pre-assembled panels of fabric are required, the panels of filter fabric shall be sewn together at the manufacturer or another approved location.

### **PART 3: FOUNDATION PREPARATION, GEOTEXTILE AND PLACEMENT**

#### **A. Foundation Preparation**

**General.** Areas on which filter fabric and cellular concrete blocks are to be placed shall be constructed to the lines and grades shown on the Contract Drawings and to the tolerances specified in the Contract Documents, and approved by the Engineer.

**Grading.** The slope shall be graded to a smooth plane surface to ensure that intimate contact is achieved between the slope face and the geotextile (filter fabric), and between the geotextile and the entire bottom surface of the cellular concrete blocks. All slope deformities, roots, grade stakes, and stones which project normal to the local slope face must be re-graded or removed. No holes, "pockmarks", slope board teeth marks, footprints, or other voids greater than 1.0 inch in depth normal to the local slope face shall be permitted. No grooves or depressions greater than 0.5 inches in depth normal to the local slope face with a dimension exceeding 1.0 foot in any direction shall be permitted. Where such areas are evident, they shall be brought to grade by placing compacted homogeneous material. The slope and slope face shall be uniformly compacted, and the depth of layers, homogeneity of soil, and amount of compaction shall be as required by the Engineer.

Excavation and preparation for anchor trenches, side trenches, and toe trenches or aprons shall be done in accordance to the lines, grades and dimensions shown in the Contract Drawings. The anchor trench hinge-point at the top of the slope shall be uniformly graded so that no dips or bumps greater than 0.5 inches over or under the local grade occur. The width of the anchor trench hinge-point shall also be graded uniformly to assure intimate contact between all cellular concrete blocks and the underlying grade at the hinge-point.

**Inspection.** Immediately prior to placing the filter fabric and cellular concrete blocks, the prepared subgrade shall be inspected by the Engineer as well as the owner's representative. No fabric or blocks shall be placed thereon until that area has been approved by each of these parties.

#### **B. Placement of Geotextile Filter Fabric**

**General.** Filter Fabric, or filtration geotextile, as specified elsewhere, shall be placed within the limits shown on the Contract Drawings.

**Placement.** The filtration geotextile shall be placed directly on the prepared area, in intimate contact with the subgrade, and free of folds or wrinkles. The geotextile shall not be walked on or disturbed when the result is a loss of intimate contact between the cellular concrete block and the geotextile or between the geotextile and the subgrade. The geotextile filter fabric shall be placed so that the upstream strip of fabric overlaps the downstream strip. The longitudinal and transverse joints shall be overlapped at least three (3) feet. The geotextile shall extend at least one foot beyond the top and bottom revetment termination points. If cellular concrete blocks are assembled and placed as large mattresses, the top lap edge of the geotextile should not occur in the same location as a space between cellular concrete mats unless the space is concrete filled.

#### **C. Placement of Cellular Concrete Blocks/Mats**

**General.** Cellular concrete block/mats, as specified in Part 2:A of these Specifications, shall be constructed within the specified lines and grades shown on the Contract Drawings.

**Placement.** The cellular concrete blocks shall be placed on the filter fabric in such a manner as to produce a smooth plane surface in intimate contact with the filter fabric. No individual block within

the plane of placed cellular concrete blocks shall protrude more than one-half inch or as otherwise specified by the Engineer. To ensure that the cellular concrete blocks are flush and develop intimate contact with the subgrade, the blocks shall be "seated" with a roller or other means as approved by the Engineer.

**Finishing.** The cells or openings in the cellular concrete blocks shall be backfilled and compacted immediately with suitable material to assure there are no voids and so that compacted material extends from the filter fabric to one-inch above the surface of the cellular concrete block. Backfilling and compaction shall be completed in a timely manner so that no more than 500 feet of exposed mats exist at any time.

[illegible]



TABLE 3. STANDARD BLOCKS SIZES							
CLASS	TYPE	BLOCK WEIGHT		BLOCK SIZE			OPEN AREA %
		Lbs (kg)	Lbs./Sq.ft. (kg/m <sup>2</sup> )	Length inches (cm)	Width inches (cm)	Height inches (cm)	
(b) (7)(E)							

## APPENDIX B FENCE & GATE STANDARD DETAILS

**DEPARTMENT OF HOMELAND SECURITY  
CUSTOMS AND BORDER PROTECTION  
FACILITIES MANAGEMENT & ENGINEERING  
BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE**

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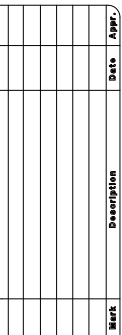
# **TACTICAL INFRASTRUCTURE (TI) FENCE AND GATE STANDARD DETAILS**

**APRIL 2012**

ACI.....	American Concrete institute
ADOT.....	Arizona Department of Transportation
ASTM.....	American Society for Testing Materials
APPROX...	Approximate
BF.....	Back Face
BM.....	Bench Mark
BOT.....	Bottom
BTWN.....	Between
CLR.....	Clear
CJ.....	Construction Joint
CONC.....	Concrete
CONT.....	Continuation
COR.....	Contracting Officer's Representative
CONST.....	Construction
DIA.....	Diameter
DIAG.....	Diagonal
DIMS.....	Dimensions
D.....	Depth
DHS.....	Department of Homeland Security
DTLS.....	Details
E.....	Easting
EA.....	Each
EJ.....	Expansion Joint
Elev.....	Elevation
EQ.....	Equal
ETC.....	Etcetera
EX.....	Existing
EXP.....	Expansion
FF.....	Front Face
FT.....	Feet/Foot
FND.....	Foundation
GA.....	Gauge
GALV.....	Galvanized
H.....	Height/High
HORZ.....	Horizontal
HSS.....	Hollow Structural Section
ID.....	Inside Dimension
IN.....	Inches
INT.....	Intermediate
INFO.....	Information
JT.....	Joint
L.....	Length
LBS.....	Pounds
LWC.....	Low Water Crossing
L.P.....	Low Point
LT.....	Left
MEG.....	Match Existing Grade
MIN.....	Minimum
MAX.....	Maximum
MCAU.....	Manufactured Concrete Armor Unit
N.T.S.....	Not to Scale
N.....	Northing
N/A.....	Not Applicable
OC.....	On Center
OD.....	Outer Diameter
P&P.....	Plan and Profile
PCC.....	Portland Cement Concrete
PF.....	Pedestrian Fence
PL.....	Plate
POE.....	Port of Entry
PSI.....	Pounds Per Square Inch
PTFE.....	Polytetrafluoroethylene
PVI.....	Point of Vertical Intersection
R.....	Radius
RD.....	Road
REINF.....	Reinforced
REQD.....	Required
RFP.....	Request for Proposal
ROW.....	Right Of Way
SHT.....	Sheet
SWR.....	Sewer
STA.....	Station
SPA.....	Space
SPECS.....	Specifications
SQ.....	Square

(b) (7)(E)

DESCRIPTION	SHEET NO.
COVER	
ABBREVIATIONS, LEGEND, AND SHEET INDEX.....	1
<b>PRIMARY PEDESTRIAN FENCE DETAILS</b>	
PICKET FENCE (TYPE P-1) SHEET 1 OF 2.....	1
PICKET FENCE (TYPE P-1) SHEET 2 OF 2.....	2
BOLLARD FENCE (TYPE P-2) SHEET 1 OF 2....	3
BOLLARD FENCE (TYPE P-2) SHEET 2 OF 2....	4
BOLLARD FENCE (TYPE P-3) SHEET 1 OF 2....	5
BOLLARD FENCE (TYPE P-3) SHEET 2 OF 2....	6
FLOATING BOLLARD FENCE (TYPE P-4) SHEET 1 OF 2.....	7
FLOATING BOLLARD FENCE (TYPE P-4) SHEET 2 OF 2.....	8
FLOATING PICKET FENCE (TYPE P-5) SHEET 1 OF 2.....	9
FLOATING PICKET FENCE (TYPE P-5) SHEET 2 OF 2.....	10
<b>SECONDARY FENCE DETAILS</b>	
MESH FENCE (TYPE S-1) SHEET 1 OF 2.....	1
MESH FENCE (TYPE S-1) SHEET 2 OF 2.....	2
<b>TERTIARY FENCE DETAILS</b>	
CHAINLINK FENCE (TYPE T-1).....	1
BARBED WIRE FENCE (TYPE T-2).....	2
<b>VEHICLE FENCE DETAILS</b>	
POST & RAIL FENCE (TYPE V-1).....	1
NORMANDY FENCE (TYP V-2) SHEET 1 OF 2....	2
NORMANDY FENCE (TYP V-2) SHEET 2 OF 2....	3
<b>SWING GATE DETAILS</b>	
PRIMARY FENCE VEHICLE GATE (TYPE G-1) .....	1
PRIMARY FENCE PEDESTRIAN GATE (TYPE G-2).....	2
PICKET STYLE PERSONNEL GATE (TYPE G-3)..	3
PRIMARY FENCE VEHICLE GATE TYPICAL DETAILS.....	4
SECONDARY FENCE VEHICLE GATE (TYPE G-4) SHEET 1 OF 2.....	5
SECONDARY FENCE VEHICLE GATE (TYPE G-4) SHEET 2 OF 2.....	6
SECONDARY FENCE PEDESTRIAN GATE (TYPE G-5).....	7
TERTIARY FENCE GATE (TYPE G-6).....	8
<b>SLIDING GATE DETAILS</b>	
PICKET FRAMED GATE (TYPE SG-1).....	1
<b>DRAINAGE GATE DETAILS</b>	
SWING DRAINAGE GATE (TYPE DG-1) SHEET 1 OF 2.....	1
SWING DRAINAGE GATE (TYPE DG-1) SHEET 2 OF 2.....	2



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CONSTRUCTION

FACILITIES MANAGEMENT & ENGINEERING BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE	Dwn by:	Cld by:	Submitted by:
	Reviewed by:		
TACTICAL INFRASTRUCTURE STAFF MEETINGS APRIL 2012	Job Number:		

ABBREVIATIONS, LEGEND  
AND SHEET INDEX

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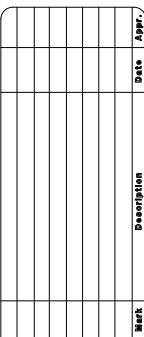
**DEPARTMENT OF HOMELAND SECURITY  
CUSTOMS AND BORDER PROTECTION  
FACILITIES MANAGEMENT & ENGINEERING  
BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE**

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# **PRIMARY PEDESTRIAN FENCE DETAILS**

**APRIL 2012**

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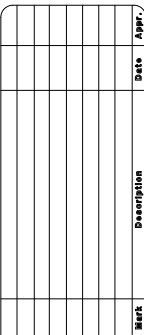
DEPARTMENT OF HOMELAND SECURITY CUSTOMS AND BORDER PROTECTION NATIONAL BORDER FORCE ENGINEERING BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE	Designed by:	Date:	Rev.
	Dwn by:	Subscribed by:	
TACTICAL INFRASTRUCTURE STANDARD DETAILS APRIL 2012	Reviewed by:	Job Number:	

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PRIMARY FENCE DETAILS

**BOLLARD FENCE  
(TYPE P-2)**

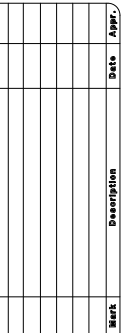
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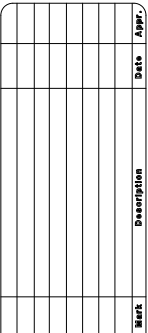


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	Reviewed by:		
TACTICAL INFRASTRUCTURE STARTING DETAILS APRIL 2012	Job Number:		

**BOLLARD FENCE  
WITH PLATE  
(TYPE P-3)  
SHEET 1 OF 2**

SHEET  
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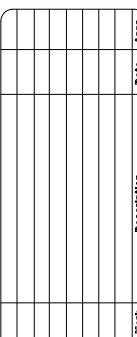
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	Reviewed by:		
	Job Number:		

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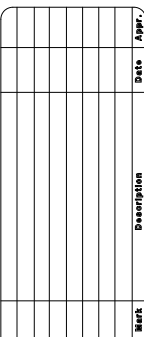
DEPARTMENT OF HOMELAND SECURITY CUSTOMS AND BORDER PROTECTION U.S. CUSTOMS AND BORDER ENGINEERING BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE	Designed by:	Date:	Rev.
	Drawn by:	Check by:	Submitted by:
	Reviewed by:	Job Number:	
TACTICAL INFRASTRUCTURE STANDARD DETAILS APRIL 2012			

PRIMARY FENCE DETAILS  
FLOATING  
BOLLARD FENCE  
(TYPE P-4)  
SHEET 2 OF 2

SHEET  
8

(b) (7)(E)

(b) (7)(E)



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PRIMARY FENCE DETAILS  
FLOATING  
PICKET FENCE  
(TYPE P-5)  
SHEET 2 OF 2

SHEET

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CUSTOMS AND BORDER PROTECTION  
FACILITIES MANAGEMENT & ENGINEERING  
BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE**

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# **SECONDARY FENCE DETAILS**

**APRIL 2012**



**Homeland  
Security**

BW FOIA CBP 002371



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BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE**

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# **TERTIARY FENCE DETAILS**

**APRIL 2012**

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CONSTRUCTION

Designed by:		Date:	Rev.
Dwn by:	Ckd by:	Submitted by:	
Reviewed by:		Job Number:	

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ENGINEERING BORDER PATROL  
FACILITIES & TACTICAL  
INFRASTRUCTURE

TACTICAL INFRASTRUCTURE  
STANDARD DETAILS  
APRIL 2012

**BARBED WIRE  
(TYPE T-2)**

SHE

2

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CUSTOMS AND BORDER PROTECTION  
FACILITIES MANAGEMENT & ENGINEERING  
BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE**

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# **PRIMARY VEHICLE FENCE DETAILS**

**APRIL 2012**



**Homeland  
Security**

(b) (7)(E)

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BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE**

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# **SWING GATE DETAILS**

**APRIL 2012**



**Homeland  
Security**

BW FOIA CBP 002381

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# **SLIDING GATE DETAILS**

**APRIL 2012**

(b) (7)(E)

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BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE**

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# **DRAINAGE GATE DETAILS**

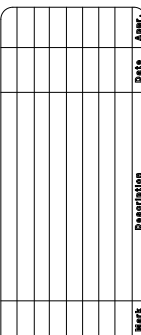
**APRIL 2012**



**Homeland  
Security**

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DRAINAGE GATE DETAILS

SWING DRAINAGE GATE  
(TYPE DG-1)  
SHEET 2 OF 2

SHEET  
2

**APPENDIX C**

**LIGHTING STANDARD DETAILS**



**DEPARTMENT OF HOMELAND SECURITY  
CUSTOMS AND BORDER PROTECTION  
FACILITIES MANAGEMENT & ENGINEERING  
BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE**

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# **TACTICAL INFRASTRUCTURE (TI) LIGHTING STANDARD DETAILS**

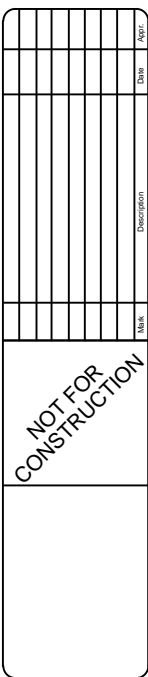
**APRIL 2012**

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DEPARTMENT OF HOMELAND SECURITY CUSTOMS AND BORDER PROTECTION U.S. CUSTOMS AND BORDER ENGINEERING BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE	Designed by:	Date:	Rev.
	Own by:	Ckd by:	Submitted by:
	Reviewed by:	Plot date:	
TACTICAL INFRASTRUCTURE STANDARD DETAILS APRIL 2012			

## TL LIGHTING STANDARDS

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(b) (7)(E)



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**APPENDIX D**

**DRAINAGE GRATE DETAIL**



**DEPARTMENT OF HOMELAND SECURITY  
CUSTOMS AND BORDER PROTECTION  
FACILITIES MANAGEMENT & ENGINEERING  
BORDER PATROL FACILITIES & TACTICAL INFRASTRUCTURE**

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# **DRAINAGE GRATE DETAILS**

**APRIL 2012**



**Homeland  
Security**

(b) (7)(E)

CULVERT GRATE  
DETAILS

SHEET  
1

DEPARTMENT OF HOMELAND SECURITY  
CUSTOMS AND BORDER PROTECTION  
ENGINEERING BORDER PATROL  
FACILITIES MANAGEMENT &  
INFRASTRUCTURE  
TACTICAL INFRASTRUCTURE  
STANDARD DETAILS  
APRIL 2012

Designed by:		Date:	Rev.
Dwn by:	Ckd by:	Submitted by:	
Reviewed by:		Job Number:	

NOT FOR  
CONSTRUCTION

Mark	Description	Date	Appr.

**APPENDIX E**

**SIGNAGE STANDARD DETAILS**



W8-3

PAVEMENT ENDS

	A	B	C	D	E	F	G	H	J	K
	24	.375	.625	4 C	2.5	.5	11.188	5.313	5.438	1.5
<b>C</b>	30	.5	.75	5 C	3	.75	13.938	6.625	6.875	1.875
	36	.625	.875	6 C	3.5	1	16.75	7.875	8.25	2.25

WARNING SIGN COLORS:

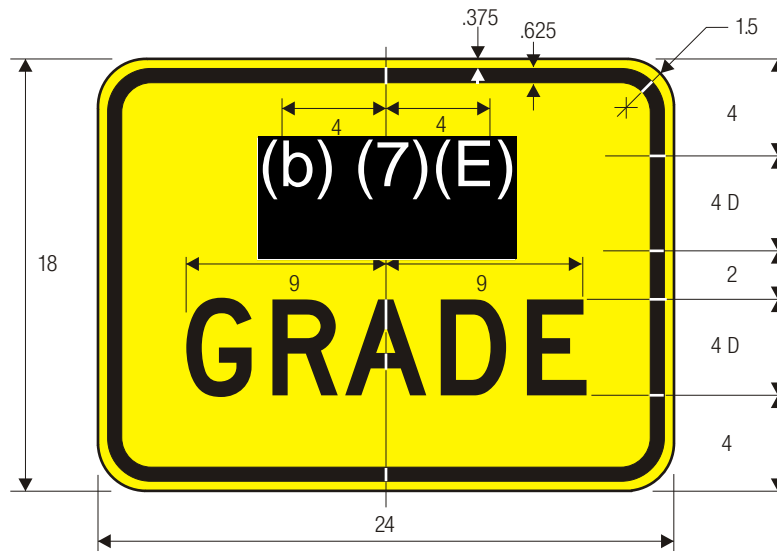
LEGEND — BLACK

BACKGROUND— YELLOW (RETROREFLECTIVE)

TTC SIGN COLORS:

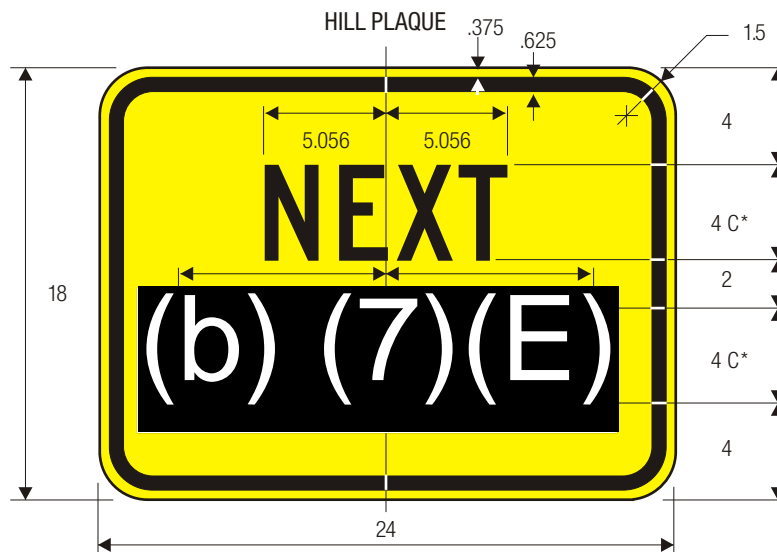
LEGEND — BLACK

BACKGROUND— ORANGE (RETROREFLECTIVE)



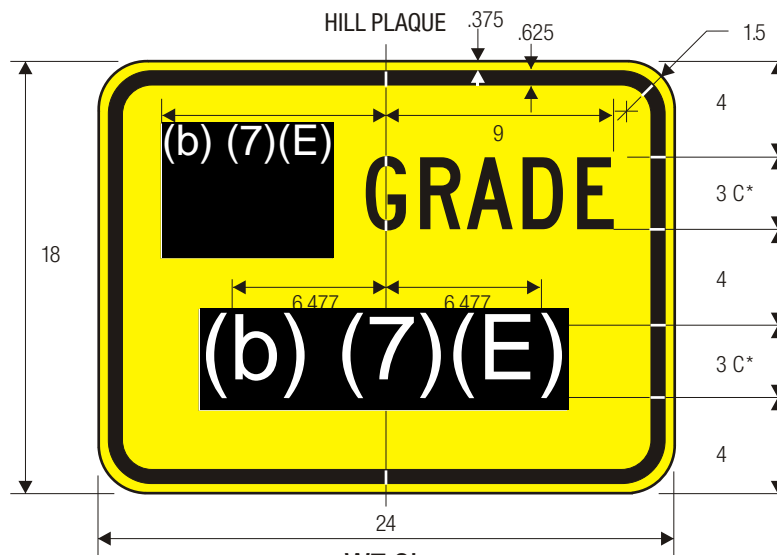
W7-3

HILL PLAQUE



W7-3a

HILL PLAQUE

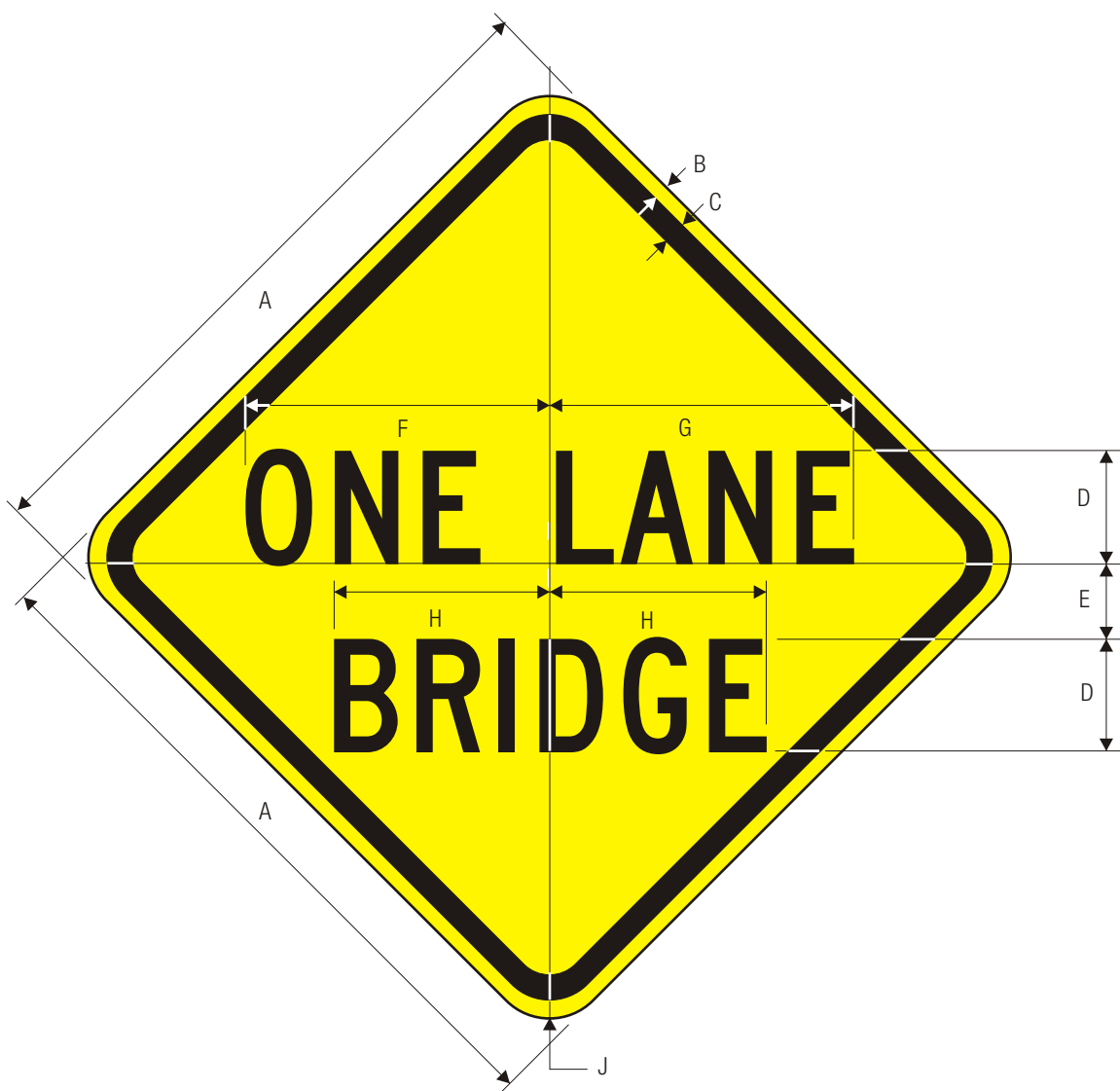


W7-3b

HILL PLAQUE

\*Series 2000 Standard Alphabets.

COLORS: LEGEND — BLACK  
BACKGROUND — YELLOW (RETROREFLECTIVE)



W5-3

ONE LANE BRIDGE

	A	B	C	D	E	F	G	H	J
	24	.375	.625	4 C	2.5	10.625	10.625	7.688	1.5
	30	.5	.75	5 C	3.25	13.313	12.688	9.125	1.875
<b>C</b>	36	.625	.875	6 C	4	16	15.25	11.5	2.25
	48	.75	1.25	8 C	5	21.25	20.25	15.375	3

WARNING SIGN COLORS:

LEGEND — BLACK

BACKGROUND— YELLOW (RETROREFLECTIVE)

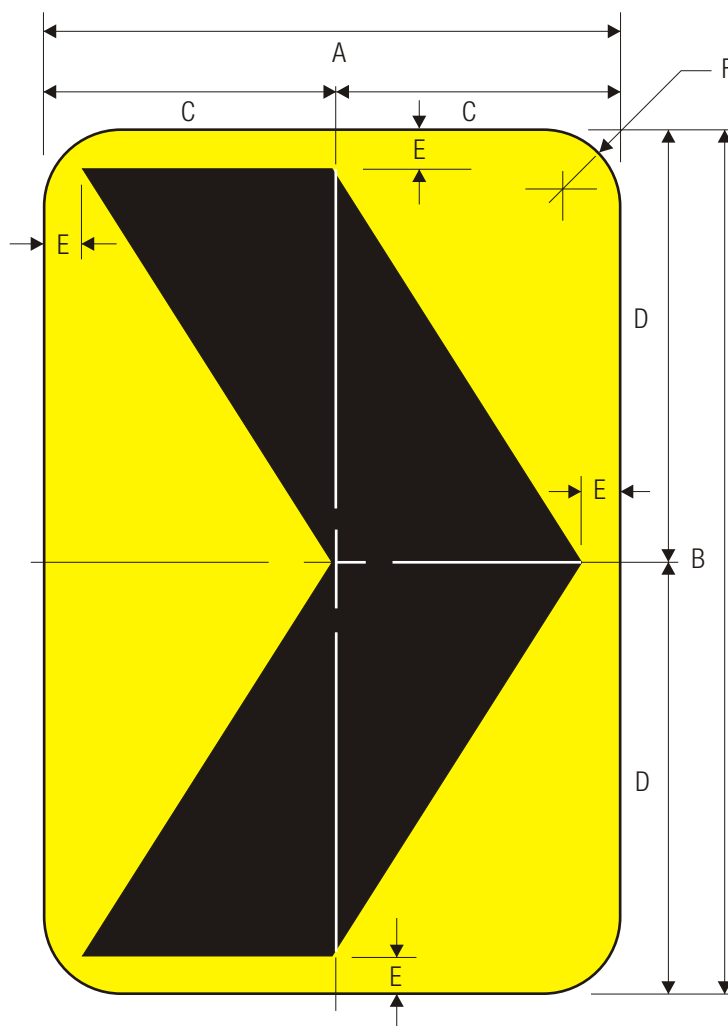
TTC SIGN COLORS:

LEGEND — BLACK

BACKGROUND— ORANGE (RETROREFLECTIVE)



W1-8L



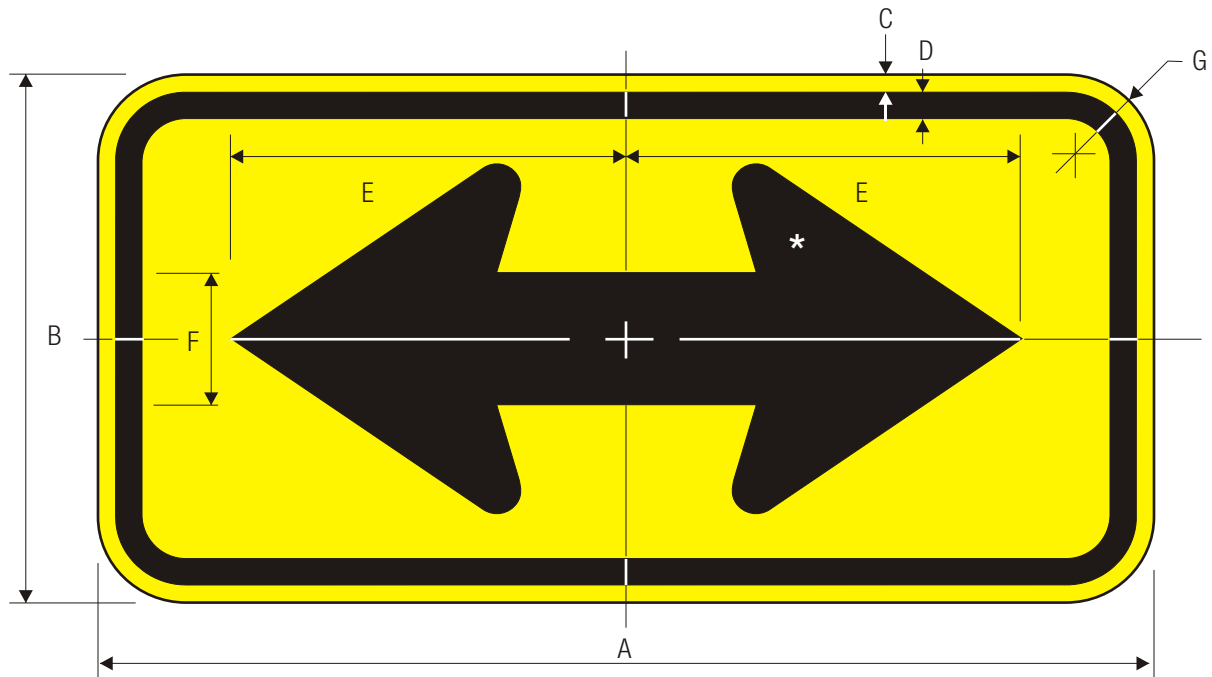
W1-8R  
CHEVRON ALIGNMENT

**C**

A	B	C	D	E	F
12	18	6	9	.5	1.5
18	24	9	12	.75	1.5
24	30	12	15	.875	1.5
30	36	15	18	1	1.875
36	48	18	24	1.125	2.25

WARNING SIGN COLORS:  
LEGEND — BLACK  
BACKGROUND— YELLOW (RETROREFLECTIVE)

TTC SIGN COLORS:  
LEGEND — BLACK  
BACKGROUND— ORANGE (RETROREFLECTIVE)



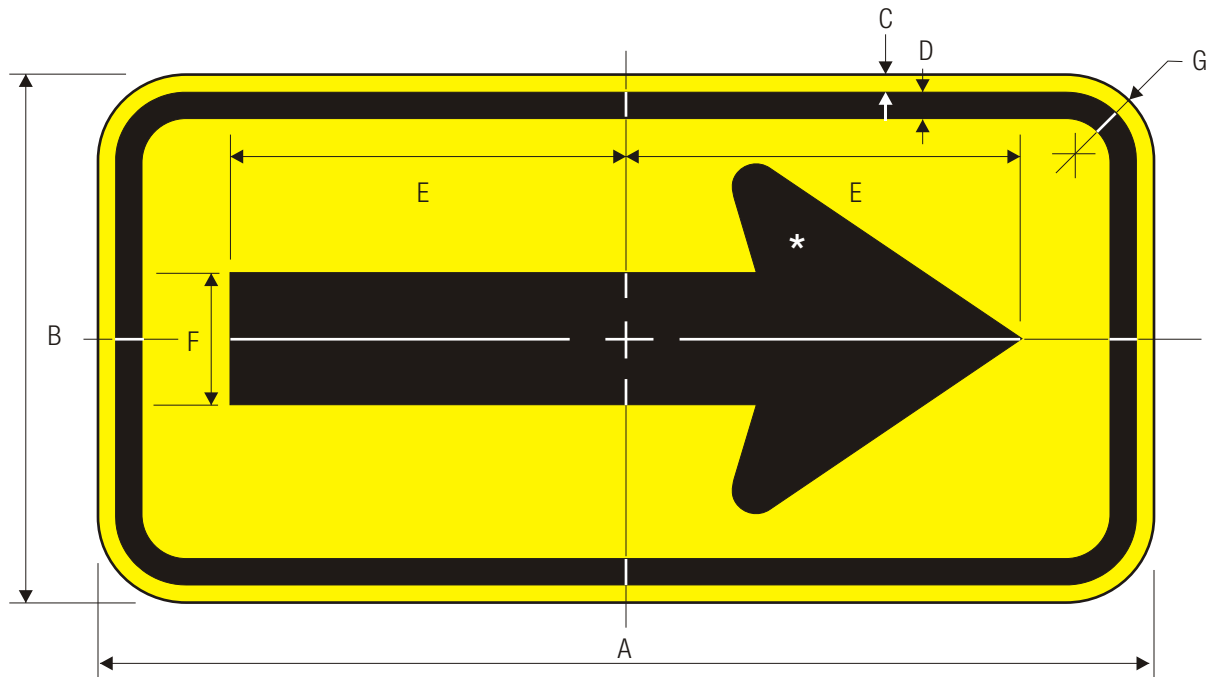
W1-7  
TWO DIRECTION LARGE ARROW

\*See standard arrow details

C	A	B	C	D	E	F	G
	24	12	.375	.625	10.375	3.25	1.5
	36	18	.375	.625	15.625	5	1.5
	48	24	.5	.75	20.5	6.5	1.875
	60	30	.625	.875	25.375	8	2.25

WARNING SIGN COLORS:  
LEGEND — BLACK  
BACKGROUND— YELLOW (RETROREFLECTIVE)





W1-6R

ONE DIRECTION LARGE ARROW



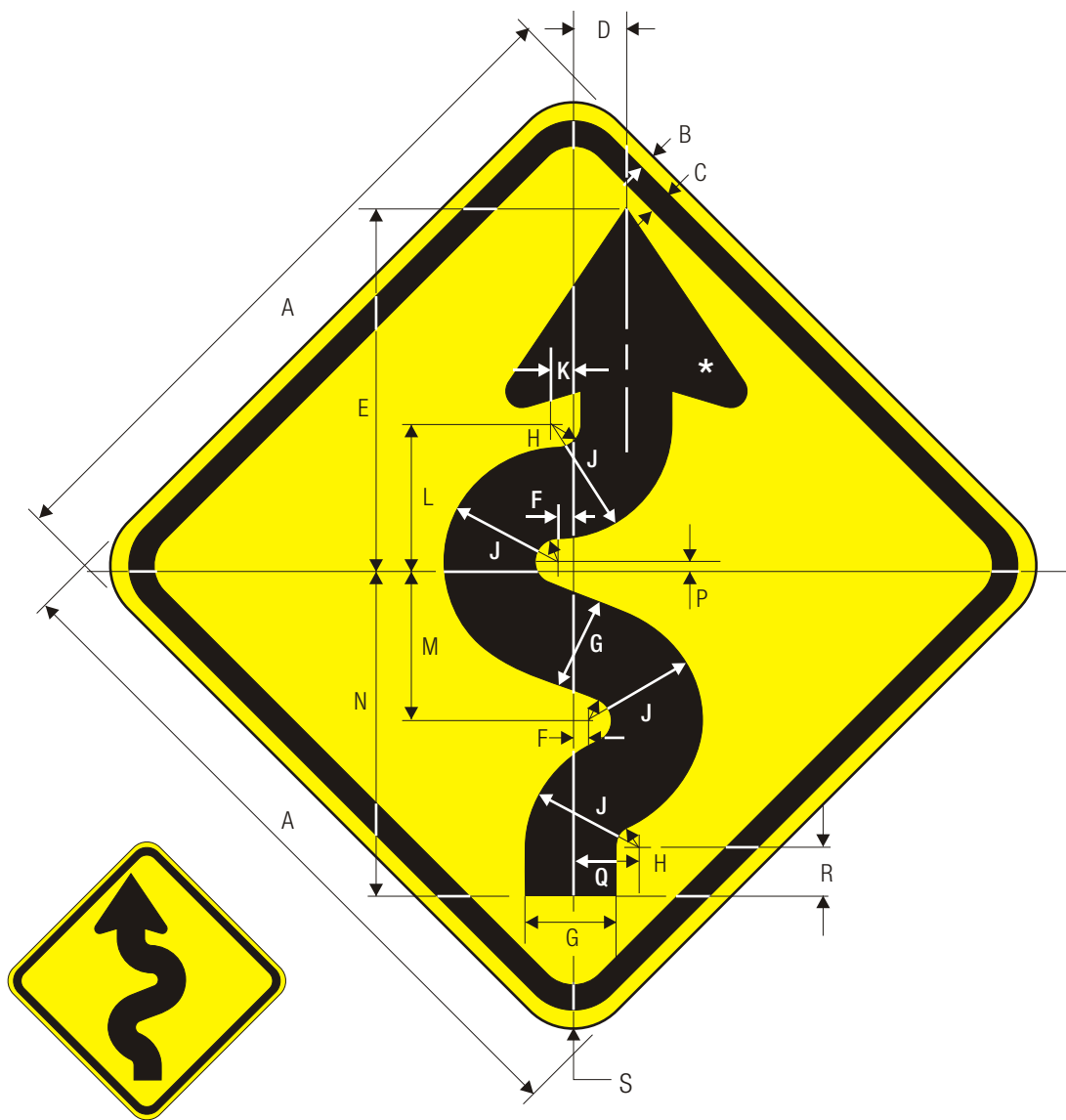
W1-6L

\*See standard arrow details

C	A	B	C	D	E	F	G
	24	12	.375	.625	9.625	3.25	1.5
	36	18	.375	.625	14.625	5	1.5
	48	24	.5	.75	19.5	6.5	1.875
	60	30	.625	.875	24.375	8	2.25

WARNING SIGN COLORS:  
 SYMBOL — BLACK  
 BACKGROUND— YELLOW (RETROREFLECTIVE)

TTC SIGN COLORS:  
 SYMBOL — BLACK  
 BACKGROUND— ORANGE (RETROREFLECTIVE)



W1-5L

W1-5R  
WINDING ROAD

\*See standard arrow details

**C**

A	B	C	D	E	F	G	H	J	K	L	M
18	.375	.625	1	9.625	.375	2.5	.625	3	1	4	4
24	.375	.625	1.25	12.75	.5	3.25	.875	4.125	1.25	5.188	5.25
30	.5	.75	1.563	15.938	.625	4.063	1.094	5.156	1.563	6.484	9.563
36	.625	.875	1.875	19.125	.75	4.875	1.313	6.188	1.875	7.781	7.875
48	.75	1.25	2.5	25.5	1	6.5	1.75	8.25	2.5	10.375	10.5

N	P	Q	R	S
8.625	.25	2	1.25	1.5
11.375	.25	2.5	1.598	1.5
14.219	.313	3.125	2	1.875
17.063	.375	3.75	2.406	2.25
22.75	.5	5	3.188	3

COLORS: LEGEND – BLACK  
BACKGROUND– YELLOW (RETROREFLECTIVE)



**R2-1**  
SPEED LIMIT (ENGLISH)

\*Optically space numerals about centerline

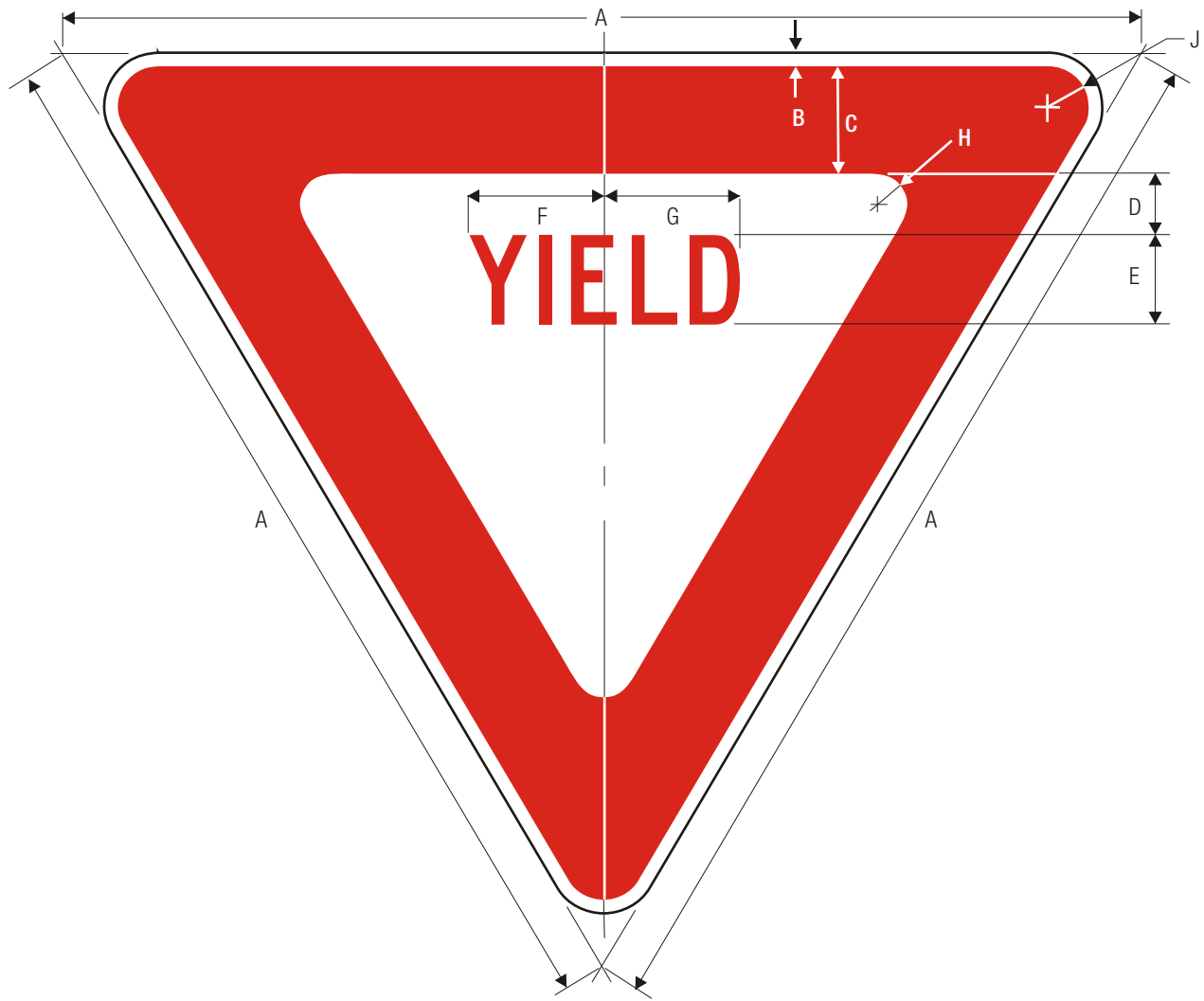
A	B	C	D	E	F	G	H	J	K	L
18	24	.375	.625	3	3 E	2	8 E	7.188	5.5	1.5
24	30	.375	.625	4	4 E	2	10 E	9.563	7.313	1.5
36	48	.625	.875	6	6 E	5	14 E	14.37	11	2.25
48	60	.75	1.25	8	8 E	6	16 E	19.125	14.625	3

COLORS: LEGEND  
BACKGROUND

BLACK  
WHITE

(RETROREFLECTIVE)

BW FOIA CBP 002414

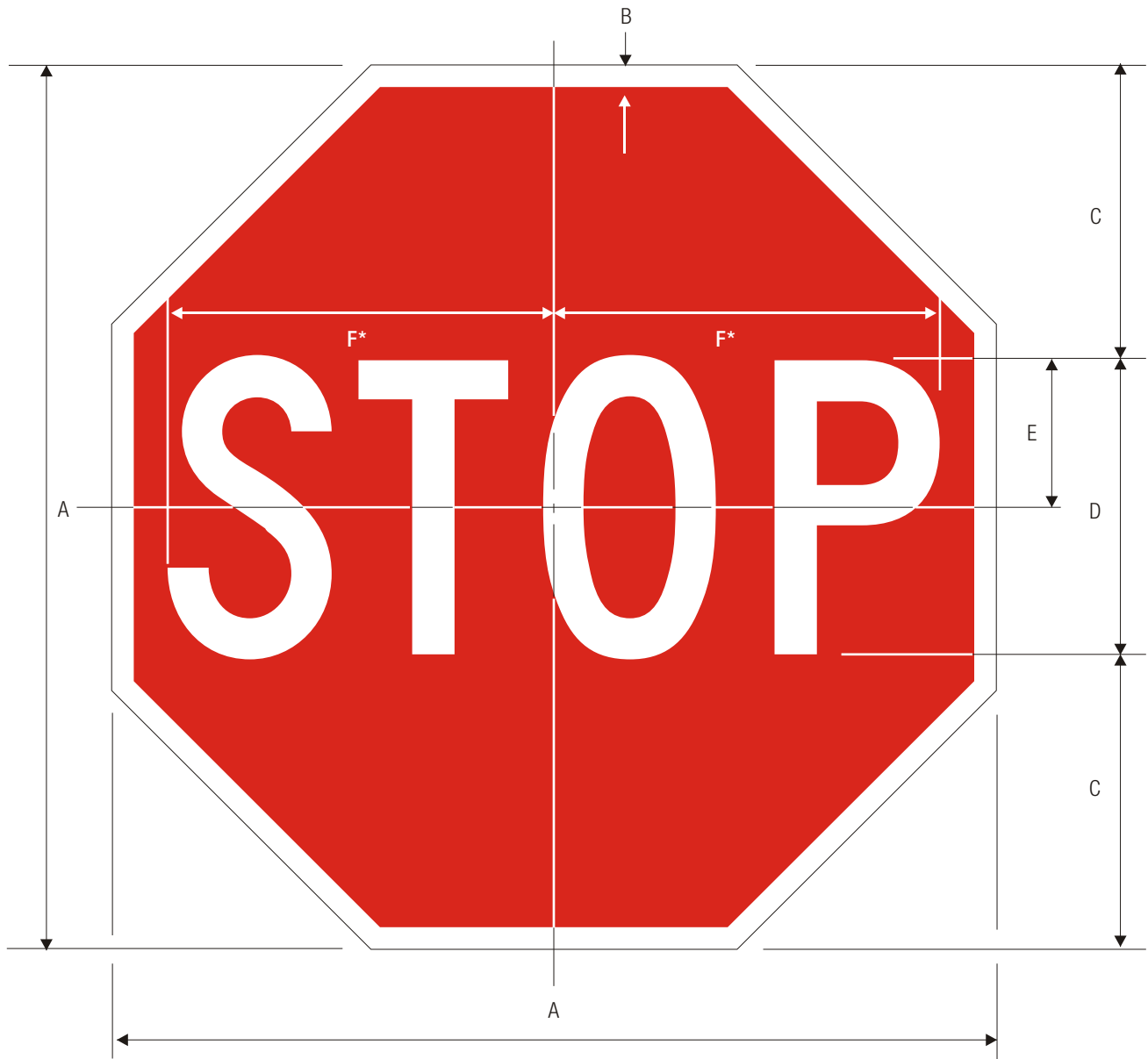


**R1-2**  
YIELD

A	B	C	D	E	F	G	H	J
18	.375	2	1	1.5 C	2.375	2.188	.625	1.5
24	.375	3	1.375	2 C	3.25	3	.875	1.5
30	.625	4	1.75	2.5 C	3.938	3.625	.875	1.5
36	.75	5	2	3 C	4.688	4.375	1.25	2
48	1	6	2.75	4 C	6.25	5.875	2	3
60	1.5	8	3.5	5 C	7.875	7.25	2.5	4

**C**

COLORS: LEGEND — RED (RETROREFLECTIVE)  
BACKGROUND — WHITE (RETROREFLECTIVE)



**R1-1**  
STOP

\*Reduce spacing 40%

<b>C</b>	A	B	C	D	E	F
	18	.375	6	6 C	3	7.75
	24	.625	8	8 C	4	10
	30	.75	10	10 C	5	12.5
	36	.875	12	12 C	6	15
	48	1.25	16	16 C	8	20

COLORS: LEGEND — WHITE (RETROREFLECTIVE)  
BACKGROUND — RED (RETROREFLECTIVE)

**APPENDIX F**

**FENCE & GATES BILL OF MATERIALS**

(b) (6)

**Subject:** Primary Fence - Floating Foundation with Pickets (Type P-5)

**Bill of Materials**

12/30/2011

Item	Item Description	Unit	Quantity/Panel	Quantity/Mile
Concrete				
1	Cast-In-Place Concrete, f'c = (b) (7)(E)	CY	(b) (7)(E)	
2	Grout, f'c = (b) (7)(E)	CY		
Steel				
3	(b) (7)(E)		EA	(b) (7)(E)
4			EA	
5			EA	
6			EA	
7			EA	
8			EA	
9			EA	
10			EA	
11			EA	
12			EA	
13			EA	
14			EA	
15			LF	
16			EA	
17			EA	
18			EA	
19			EA	

Note:

These quantities should be considered approximate and are for planning purposes only.

(b) (6)

**Subject:** Primary Fence - Picket (Type P-1) Slope > 30%

**Bill of Materials**

12/30/2011

Item	Item Description	Unit	Quantity/Panel	Quantity/Mile
Concrete				
1	Cast-In-Place Concrete, f'c = (b) (7)(E)	CY	(b) (7)(E)	
2	Grout, f'c = (b) (7)(E)	CY	(b) (7)(E)	
Steel				
3	(b) (7)(E)		EA	(b) (7)(E)
4			EA	
5			EA	
6			EA	
7			EA	
8			EA	
9			EA	
10			EA	
11			EA	

Note:

These quantities should be considered approximate and are for planning purposes only.



(b) (6)

**Subject:** Primary Fence - Bollards (Type P-2) Slope < 30%

**Bill of Materials**

12/30/2011

Item	Item Description	Unit	Quantity/Panel	Quantity/Mile
Concrete				
1	Cast-In-Place Concrete, f'c = (b) (7)(E)	CY	(b) (7)(E)	
2	Grout, f'c = (b) (7)(E)	CY		
Steel				
3	(b) (7)(E)	EA	(b) (7)(E)	
4		EA		
5		EA		
5		EA		
6		EA		
7		EA		
7		EA		
8		EA		

Note:

These quantities should be considered approximate and are for planning purposes only.

(b) (6)

**Subject:** Primary Fence - Bollards (Type P-2) Slope > 30%

**Bill of Materials**

12/30/2011

Item	Item Description	Unit	Quantity/Panel	Quantity/Mile
Concrete				
1	Cast-In-Place Concrete, f'c = (b) (7)(E)	CY	(b) (7)(E)	
2	Grout, f'c = (b) (7)(E)	CY		
Steel				
3	(b) (7)(E)		EA	(b) (7)(E)
4			EA	
5			EA	
5			EA	
6			EA	
7			EA	
7			EA	
8			EA	

Note:

These quantities should be considered approximate and are for planning purposes only.

(b) (6)

**Subject:** Primary Fence - Bollards (Type P-3) Slope < 30%

**Bill of Materials**

12/30/2011

Item	Item Description	Unit	Quantity/Panel	Quantity/Mile
Concrete				
1	Cast-In-Place Concrete, f'c = (b) (7)(E)	CY	(b) (7)(E)	
2	Grout, f'c = (b) (7)(E)	CY		
Steel				
3	(b) (7)(E)		EA	(b) (7)(E)
4			EA	
5			EA	
6			EA	
7			EA	
8			EA	
9			EA	
10			EA	
11			EA	
12			EA	

Note:

These quantities should be considered approximate and are for planning purposes only.

(b) (6)

**Subject:** Primary Fence - Bollards (Type P-3) Slope > 30%

**Bill of Materials**

12/30/2011

Item	Item Description	Unit	Quantity/Panel	Quantity/Mile
<b>Concrete</b>				
1	Cast-In-Place Concrete, f'c = (b) (7)(E)	CY	(b) (7)(E)	
2	Grout, f'c = (b) (7)(E)	CY	(b) (7)(E)	
<b>Steel</b>				
3	(b) (7)(E)	EA	(b) (7)(E)	
4	(b) (7)(E)	EA	(b) (7)(E)	
5	(b) (7)(E)	EA	(b) (7)(E)	
6	(b) (7)(E)	EA	(b) (7)(E)	
7	(b) (7)(E)	EA	(b) (7)(E)	
8	(b) (7)(E)	EA	(b) (7)(E)	
9	(b) (7)(E)	EA	(b) (7)(E)	
10	(b) (7)(E)	EA	(b) (7)(E)	
11	(b) (7)(E)	EA	(b) (7)(E)	
12	(b) (7)(E)	EA	(b) (7)(E)	

Note:

These quantities should be considered approximate and are for planning purposes only.

(b) (6)

**Subject:** Secondary Fence (Type S-1)

**Bill of Materials**

12/30/2011

Item	Item Description	Unit	Quantity/Panel	Quantity/Mile
<b>Concrete</b>				
1	CIP Concrete f'c = (b) (7)(E)	CY	(b) (7)(E)	
<b>Steel</b>				
2	(b) (7)(E)		EA	(b) (7)(E)
3			EA	
4			EA	
5			EA	
6			EA	
7			EA	
8			EA	
9			EA	
10			EA	

Note:

These quantities should be considered approximate and are for planning purposes only.

(b) (6)

Subject: Tertiary Fence (Type T-1)

Bill of Materials

12/30/2011

Item	Item Description	Unit	Quantity/Panel	Quantity/Mile
<b>Concrete</b>				
1	Cast-In-Place Concrete, f'c = (b) (7)(E)	CY	(b) (7)(E)	
<b>Steel</b>				
2	(b) (7)(E)		LF	(b) (7)(E)
3			EA	
3			EA	
7			EA	
8			EA	
3			EA	
10			EA	

Note:

These quantities should be considered approximate and are for planning purposes only.

(b) (6)

**Subject:** Tertiary Fence (Type T-2)

**Bill of Materials**

12/30/2011

Item	Item Description	Unit	Quantity/Panel	Quantity/Mile
5	(b) (7)(E)	LF	(b) (7)(E)	(b) (7)(E)
3		EA		
3		EA		
7		EA		
8		EA		

Note:

These quantities should be considered approximate and are for planning purposes only.

(b) (6)

Subject: Vehicle Fence (Type V-1)

Bill of Materials

12/30/2011

Item	Item Description	Unit	Quantity/Panel	Quantity/Mile
Concrete				
1	CIP Concrete f'c = (b) (7)(E)	CY	(b) (7)(E)	
2	Grout f'c = (b) (7)(E)	CY	(b) (7)(E)	
Steel				
3	(b) (7)(E)		EA	(b) (7)(E)
4			EA	
5			EA	
5			EA	
6			EA	
7			EA	
8			EA	

Note:

These quantities should be considered approximate and are for planning purposes only.



(b) (6)

**Subject:** Vehicle Fence (Type V-2)

**Bill of Materials**

12/30/2011

Item	Item Description	Unit	Quantity/Panel	Quantity/Mile
<u>Steel</u>				
1	(b) (7)(E)	EA	(b) (7)(E)	(b) (7)(E)
2		EA		
3		EA		
4		EA		
4		EA		
4		EA		
4		EA		
4		EA		
1		EA		

Note:

These quantities should be considered approximate and are for planning purposes only.

Subject: Swing Gate (Type G-1)

## Bill of Materials

12/30/2011

Item	Item Description	Unit	Quantity/Gate
Concrete			
1	CIP Concrete, f'c = (b) (7)(E)	CY	(b) (7)(E)
2	Grout, f'c = (b) (7)(E)	CY	
Steel			
2	(b) (7)(E)		EA
3			EA
3			EA
4			EA
5			EA
6			EA
7			EA
8			EA
9			EA
10			EA
11			EA
12			EA
13			EA
14			EA
15			EA
16			EA
17			EA
18			EA
19			EA

Note:

These quantities should be considered approximate and are for planning purposes only.

Subject: Swing Gate (Type G-2)

## Bill of Materials

12/30/2011

Item	Item Description	Unit	Quantity/Gate
<b>Concrete</b>			
1	CIP Concrete, f'c = (b) (7)(E)	CY	(b) (7)(E)
2	Grout, f'c = (b) (7)(E)	CY	
<b>Steel</b>			
2	(b) (7)(E)	EA	(b) (7)(E)
3		EA	
3		EA	
4		EA	
5		EA	
6		EA	
7		EA	
8		EA	
9		EA	
10		EA	
11		EA	
12		EA	
13		EA	
14		EA	
15		EA	
16		EA	
17		EA	
18		EA	
19		EA	

Note:

These quantities should be considered approximate and are for planning purposes only.

Subject: Swing Gate (Type G-3)

## Bill of Materials

12/30/2011

Item	Item Description	Unit	Quantity/Gate
<b>Concrete</b>			
1	CIP Concrete, f'c = (b) (7)(E)	CY	(b) (7)(E)
2	Grout, f'c = (b) (7)(E)	CY	
<b>Steel</b>			
2	(b) (7)(E)	EA	(b) (7)(E)
3		EA	
3		EA	
4		EA	
5		EA	
6		EA	
7		EA	
8		EA	
9		EA	
10		EA	
12		EA	
13		EA	
15		EA	
16		EA	
17		EA	
18		EA	
19		EA	

Note:

These quantities should be considered approximate and are for planning purposes only.

Subject: Swing Gate (Type G-4)

Bill of Materials

12/30/2011

Item	Item Description	Unit	Quantity
<b>Concrete</b>			
1	CIP Concrete, f'c = (b) (7)(E)	CY	(b) (7)(E)
<b>Steel</b>			
2	(b) (7)(E)	EA	(b) (7)(E)
3		EA	
4		EA	
5		EA	
6		EA	
7		EA	
8		EA	
9		EA	
10		EA	
11		EA	
12		EA	
13		EA	
14		EA	
15		EA	
16		EA	
17		EA	
18		EA	
19		EA	

Note:

These quantities should be considered approximate and are for planning purposes only.

Subject: Swing Gate (Type G-5)

Bill of Materials

12/30/2011

Item	Item Description	Unit	Quantity
<b>Concrete</b>			
1	CIP Concrete, f'c = (b) (7)(E)	CY	(b) (7)(E)
<b>Steel</b>			
2	(b) (7)(E)		
3			
4			
9			
6			
7			
8			
8			
6			
10			
11			
15			
16			
17			
18			
19			
19			

Note:

These quantities should be considered approximate and are for planning purposes only.

(b) (6)

Subject: Swing Gate (Type G-6)

Bill of Materials

12/30/2011

Item	Item Description	Unit	Quantity
<b>Concrete</b>			
1	Concrete, F'c=(b) (7)(E) TxDOT Class C	CY	(b) (7)(E)
<b>Steel</b>			
2	(b) (7)(E)	LF	(b) (7)(E)
3		EA	
6		EA	
7		EA	
8		EA	
9		EA	
10		EA	
11		EA	
12		EA	

(b) (6)

Subject: Sliding Type 1 (b) (7)(E)

Bill of Materials

12/30/2011

Item	Item Description	Unit	Quantity
<b>Concrete</b>			
1	Concrete, F'd (b) (7)(E) TxDOT Class C	CY	(b) (7)(E)
<b>Steel</b>			
4	(b) (7)(E)		EA
5			EA
6			EA
7			SF
8			EA
<b>Miscellaneous</b>			
9			
10			



APPENDIX G	AUTOMATED/MOTORIZED VEHICLE GATES	PRIMARY	PEDESTRIAN	FENCE
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